TECHNOLOGY DEPARTMENT

INDEX 1958

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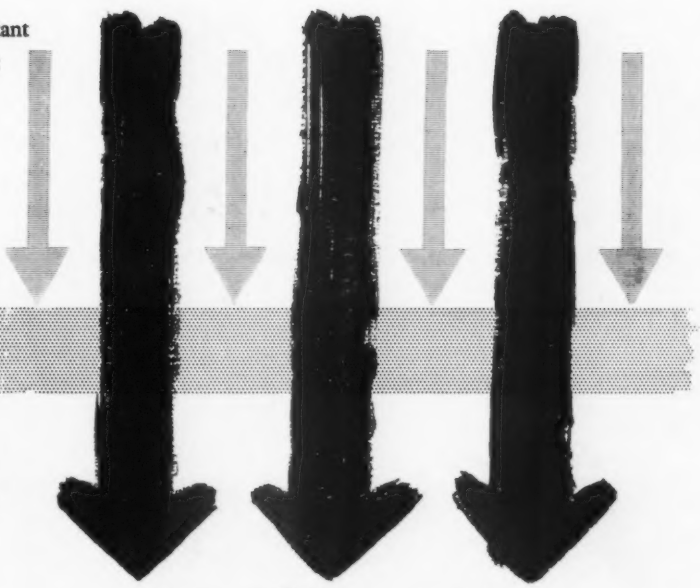

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INDEX TO ADVERTISERS

	Page
A.P.V. Co. Ltd., The	Nov.
African Pyrethrum Tech. Information Centre Ltd.	A95
Air Drying and Conditioning Ltd.	A9
Aiton & Co. Ltd.	A5
Albro Fillers & Engg. Co. Ltd.	Nov.
Alginate Industries Ltd.	A88
Alite Machines Ltd.	Nov.
Allen, Stafford, & Sons Ltd.	Nov.
Alwitt Trading Co. Ltd.	A60
Amplex Appliances (Kent) Ltd.	Nov.
Anderson, C. F., & Son Ltd.	Nov.
Anhydro A/S	A62
Apex Construction Ltd.	Nov.
Arden, H. B., & Co. Ltd.	A92
Arthol Ltd.	A28
Ashby, Morris, Ltd.	A80
Atcost Ltd.	A55
B. & P. Laboratories Ltd.	A82
B.U. Supplies & Machinery Co. Ltd.	A75
Baird & Tatlock (London) Ltd.	Cover I
Baker Platinum Ltd.	Nov.
Barter Trading Corporation	A42
Beatson, Clark & Co. Ltd.	A14
Bencard, C. L., Ltd.	Sept.
Benjamin, The, Electric Ltd.	A12
Berk, F. W., & Co. Ltd.	A52, A96
Betts & Co. Ltd.	Oct.
Birlec Ltd.	Nov.
Bramigk & Co. Ltd.	A76
Briggs, S., & Co. Ltd.	A85
British Ceca Co. Ltd.	A94
British Celanese Ltd.	A27
British Drug Houses Ltd., The	A4
British LaBour Pump Co.	A61
British Overseas Airways Corp.	A7
British Railways	A92
Broadbent, Thomas, & Sons Ltd.	A56
Brome & Schimmer Ltd.	Nov.
Bromhead & Denison Ltd.	Sept.
Brown, Arthur, & Co. Ltd.	Nov.
Burroughs Wellcome & Co. Ltd.	A10
Bush, Beach & Gent Ltd.	A96
Bush, W. J., & Co. Ltd.	A19
Butterfield, W. P., Ltd.	Nov.
Calfos Ltd.	Nov.
Calmic Engineering Co. Ltd.	A15
Cambridge Instrument Co. Ltd.	Oct.
Carless, Capel & Leonard Ltd.	Nov.
Carlson, John C., Ltd.	A73
Chemapol	Cover 3
Chemicals & Feeds Ltd.	A98
Chilean Iodine Educational Bureau	Nov.
China National Import & Export Corp.	A77
Christensen, Lars	Sept.
Clark, Geo. & Sons (Hull) Ltd.	A71
Clark, T. & C. Ltd.	Nov.
Clarke-Built Ltd.	Nov.
Classified Advertisements	A99-A100
Coalite & Chemical Products Ltd.	A64
Cocker Chemical Co. Ltd.	Nov.
Colodense Ltd.	A37
Cornwell Products Ltd.	Nov.
Cow, P. B., & Co. Ltd.	Nov.
Cox, Arthur H., & Co. Ltd.	A73
Crocq., Jean A. du Jr. N.V.	A91
Cumming, J. W., & Son Ltd.	A98
Dawson Bros. Ltd.	Nov.
Deckelmann, Josef	A98
Dehydag	Nov.
Delf, W. M., (Liverpool) Ltd.	A97
Distillers, The, Co. Ltd.	Nov.
Dore, John, & Co. Ltd.	Nov.
Doulton Industrial Porcelains Ltd.	Sept.
Dragoco	Nov.
Dutton & Renisch Ltd.	Nov.
Edwards High Vacuum Ltd.	Nov.
Electrothermal Engineering Ltd.	Nov.
Enamelled Metal Products Corporation	Oct.
Engineering Dev. (England) Ltd.	A90
English Clays, Lovering Pochin & Co. Ltd.	A70
Evans Chemicals Ltd.	A6
Evans Medical Supplies Ltd.	A51
Evans, Norman, & Rais Ltd.	A72
Evode Ltd.	A63
Excorna	A96
Farrow & Jackson Ltd.	A66
Fatoils Ltd.	Nov.
Firth Vickers Stainless Steels Ltd.	Sept.
Flexile Metal Co. Ltd.	A40
Fluid Equipment Co. Ltd.	A93
Foster, Yates & Thom Ltd.	Nov.
Fritsch, Alfred	Nov.
Fritsch, Rudolph, W.	A96
Funditor Ltd.	Oct.
Gale, Ronald, & Co. Ltd.	July
Gardner, Wm., & Sons (Gloucester) Ltd.	Nov.
Giusti, T., & Son Ltd.	Nov.
Givaudan, L., & Co. Ltd.	A54
Glass Containers Ltd.	A93
Glastics Ltd.	Nov.
Glaxo Laboratories Ltd.	A75
Glen Creston Ltd.	Nov.
Glovers (Chemicals) Ltd.	A35
Gosheron, John, & Co. Ltd.	Nov.
Graesser Salicylates Ltd.	A83
Graesser-Thomas, H. W., Ltd.	Nov.
Griffin & George Ltd.	Nov.
Gurr, Edward, Ltd.	A98
Haller & Phillips Ltd.	A92
Harris, F. & R. M., (Birm.) Ltd.	Nov.
Harvey, G. A., & Co. (London) Ltd.	A74
Hatherware Ltd.	Nov.
Haworth (A.R.C.) F., Ltd.	Nov.
Head Wrightson Processes Ltd.	Nov.
Herbert, Alford Ltd.	A48
Herbst, F., & Co.	A98
Hilger & Watts Ltd.	Nov.
Hobart Mfg. Co. Ltd.	Nov.
Honeywill Atlas Ltd.	A77
Honeywill & Stein Ltd.	Nov.
Horner, L. A., & Sons Ltd.	Nov.
Hunt & Moscrop Ltd.	Nov.
Ideal Capsules Ltd.	A76
Impact Extrusions Ltd.	Sept.
Imperial Chemical Industries Ltd.	A22, A25, A26, A32, A41
Industrial Models Ltd.	Sept.
International Bottle Co. Ltd.	Nov.
Isopad Ltd.	Sept.
Jacobson Van Den Berg & Co. (U.K.) Ltd.	Nov.
Johnsen & Jorgensen Ltd.	Nov.
Johnson, S. H., & Co. Ltd.	Nov.
Jones, Samuel, & Co. Ltd.	A70

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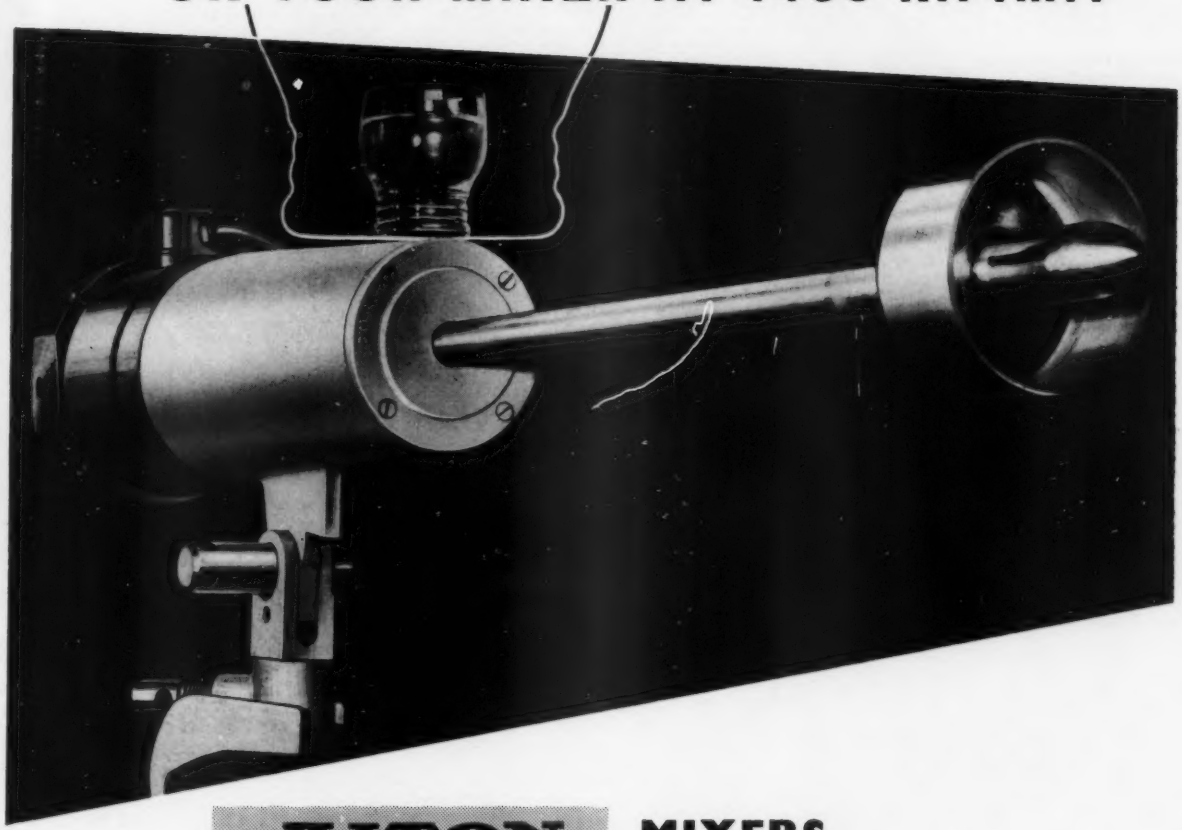

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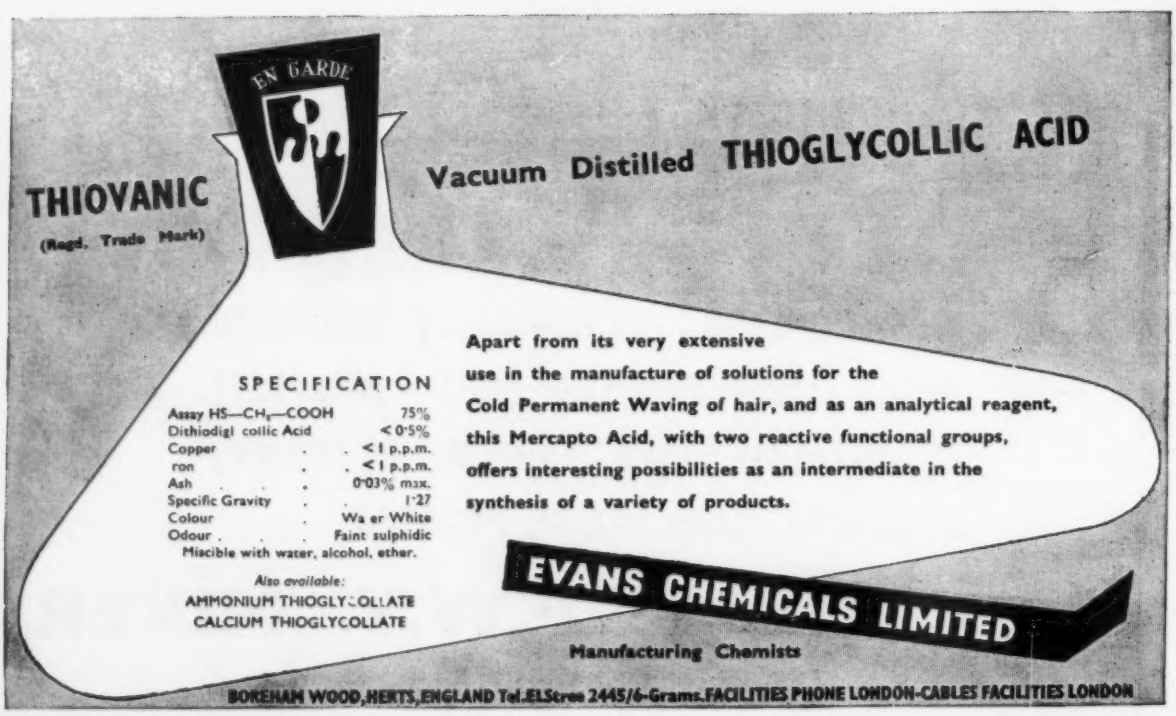
INDEX TO ADVERTISERS

	Page
Kaylene (Chemicals) Ltd.	A78
Kek Ltd.	Nov.
Kellys, John, (London) Ltd.	A97
Kemball, Bishop & Co. Ltd.	Oct.
Kenwall Engineering Co.	Nov.
Kendall, F., & Son Ltd.	A98
Kestner Evaporator & Engg. Co. Ltd.	A74, A87
Kingsley & Keith Ltd.	Sept.
Kolmar Cosmetics (England) Ltd.	Nov.
Kork-N-Seal Ltd.	A20
K. W. Chemicals Ltd.	A94
Laminated Plastic Products Ltd.	Oct.
Lankro Chemicals Ltd.	Nov.
Lattimer, H.	A98
Lautier Fils	Nov.
Lavino (London) Ltd.	Nov.
Lawtons of Liverpool Ltd.	A78
Lax & Shaw Ltd.	Nov.
Lennox Foundry Co. Ltd.	A80
Leverton Myers Ltd.	Nov.
M.G.K. Engineering Co. Ltd.	Oct.
McKesson & Robbins Ltd.	A98
Maine, B. Newton, Ltd.	A89
Manchester Oil Refinery (Sales) Ltd.	A39
Manesty Machines Ltd.	Nov.
Manlove Alliot & Co. Ltd.	Nov.
Manning, A. J., Ltd.	Nov.
Marchon Products Ltd.	A46
Martin, W. H., Ltd.	A95
Mason & Morton Ltd.	A72
May & Baker Ltd.	A21
Metalfiltration Co. Ltd., The	A85
Metal Box Co. Ltd., The	Cover 2, A23
Metal Closures Ltd.	Nov.
Metal Hydrides Inc.	Nov.
Metalitho Ltd.	A33
Miller, Joseph & Sons Ltd.	A90
Minnesota Mining & Mfg. Co. Ltd.	Oct.
Mitchell, L. A., Ltd.	Nov.
Mono Pumps Ltd.	A89
Monsanto Chemicals Ltd.	A45
Morgan Fairest Ltd.	A47
Moritz Chemical Engg. Ltd.	Nov.
Morson, Thomas, & Son Ltd.	Cover 4
National Glass Work (York) Ltd.	A24
Olley, C., & Sons Ltd.	A94
Page, Chas., & Co. Ltd.	A96
Palfrey, Wm. Ltd.	A50
Pascall Engineering Co. Ltd.	Nov.
Paterson Engineering Co. Ltd.	A90
Pearce, L. R. B., Ltd.	Nov.
Pearlite Box Co. Ltd.	A86
Peerless & Ericsson Ltd.	A16
Petley, P. T. & Co. Ltd.	A95
Petrie & McNaught Ltd.	A67
Petrochemicals Ltd.	A69
Pharmaceutical Press, The	A86
Plastic Closures Ltd.	Oct.
Plenty & Son Ltd.	A18
Polak & Schwarz Ltd.	A31
Poth, Hille & Co. Ltd.	A82
Potter & Clarke Ltd.	A87
Premier Colloid Mills Ltd.	A53
Prices (Bromborough) Ltd.	Oct.
Professional Sales Corp.	Oct.
Pulverizing Machinery Ltd.	Oct.
Purdy Machinery Co. Ltd.	A66
Pyrene Co. Ltd.	Oct.
Pyrocell Mfg. Co.	Nov.
Q.V.F. Ltd.	Oct.
Quickfit & Quartz Ltd.	A65
Reads Ltd.	Sept.
Read, R. F., Ltd.	A84
Reed Corrugated Cases Ltd.	A58
Rejafix Ltd.	Nov.
Renham & Romley Ltd.	Nov.
Rexolin Chemicals	Oct.
Rhone-Poulenc, Soc. de Usines Chimiques	Nov.
Richford, E. M., Ltd.	A95
Riley (IC) Products Ltd.	A43
Roberts Patent Filling Machine Co. Ltd.	A79
Robinson Brothers Ltd.	Nov.
Robinson & Sons Ltd.	Oct.
Roche Products Ltd.	A3
Rockwell Pneumatic Scale Ltd.	A59
Rodway & Taylor	A92
Ronsheim & Moore Ltd.	Oct.
Roussel Laboratories Ltd.	Nov.
Saniguard Appliances Ltd.	Nov.
Scandinavian	A8
Scherer, R. P., Ltd.	Oct.
Service Electric Co. Ltd.	Nov.
Shandon Scientific Co. Ltd.	Nov.
Shell Chemical Co. Ltd.	A13, A69
Silverson Machine (Sales) Ltd.	A81
Simpson, W. S., & Co. Ltd.	A98
Sipon Products Ltd.	Nov.
Smith, T. & H., Ltd.	A36
Smiths Industrial Inst. Div.	A30
Southern Apparatus Co. Ltd.	A88
Spicers Ltd.	A17
Standard Synthetics Ltd.	Oct.
Staveley Iron & Chemical Co. Ltd., The	A29
Steel, J. M., & Co. Ltd.	Nov.
Stephens Bros. & Banner Ltd.	Nov.
Sturge, J. & E., Ltd.	Nov.
Sturtevant Engineering Co. Ltd.	A49
Sutalite Ltd.	Nov.
Sutcliffe Speakman & Co. Ltd.	Nov.
Tan-Sad Chair Co. (1931) Ltd.	Nov.
Taylor Rustless Fittings Co. Ltd.	A83
Tennants (Lancashire) Ltd.	A97
Thames Board Mills Ltd.	Nov.
Thames Sack & Bag Co. Ltd.	A11
Thermocontrol Installations Ltd.	Nov.
Thompson & Capper Ltd.	Nov.
Trade Agent for Mysore	A97
Trade Commissioner for the British West Indies, British Guiana and British Honduras	A98
Tungstone Products Ltd.	A68
Tye, John, & Son Ltd.	Nov.
Ultrasonics Ltd.	A34
Union Carbide Ltd.	Oct.
United Glass Bottle Manfrs. Ltd.	Nov.
United Indigo & Chemical Co. Ltd.	A96
Universal Metal Products Ltd.	Oct.
Universal Oil Co. Ltd.	A57
Venesta Ltd.	Sept.
Viscose Development Co. Ltd.	A44
Vitamins Ltd.	A81
Warwick Production Co. Ltd.	Nov.
Watson, W., & Sons Ltd.	Oct.
Weatherfoil Heating Systems Ltd.	Nov.
Welch, J. A. (Plant & Vessel) Ltd.	Nov.
Westbrook Lanolin Co.	A79
Whaley, Bridge Partnership Ltd., The	A94
White Sea and Baltic Co.	Nov.
Willcox, W. H., Co. Ltd.	A38
Woodhams, Dade & Co.	A96
Wood-Wool & Fibre Co. Ltd.	Oct.
Wynmouth Lehr & Co. Ltd.	A98
Wynn (Valves) Ltd.	A91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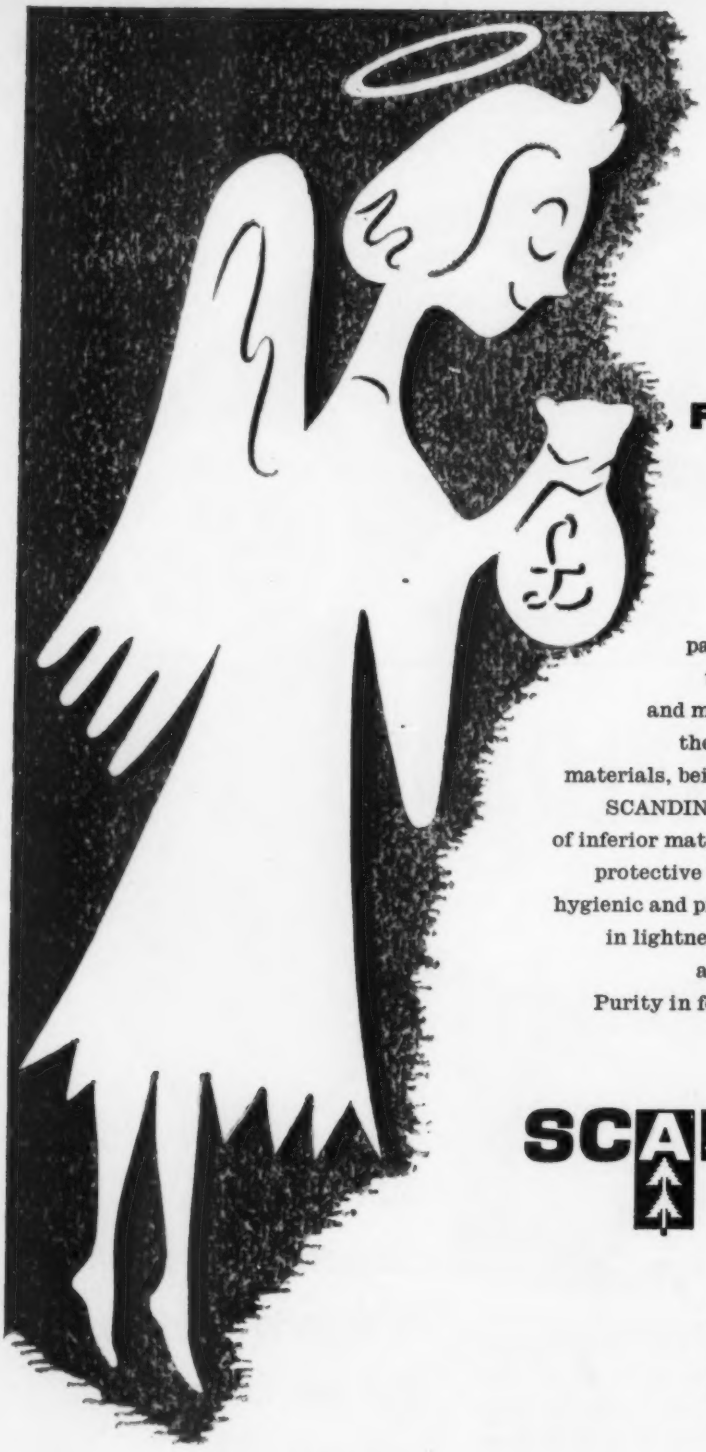

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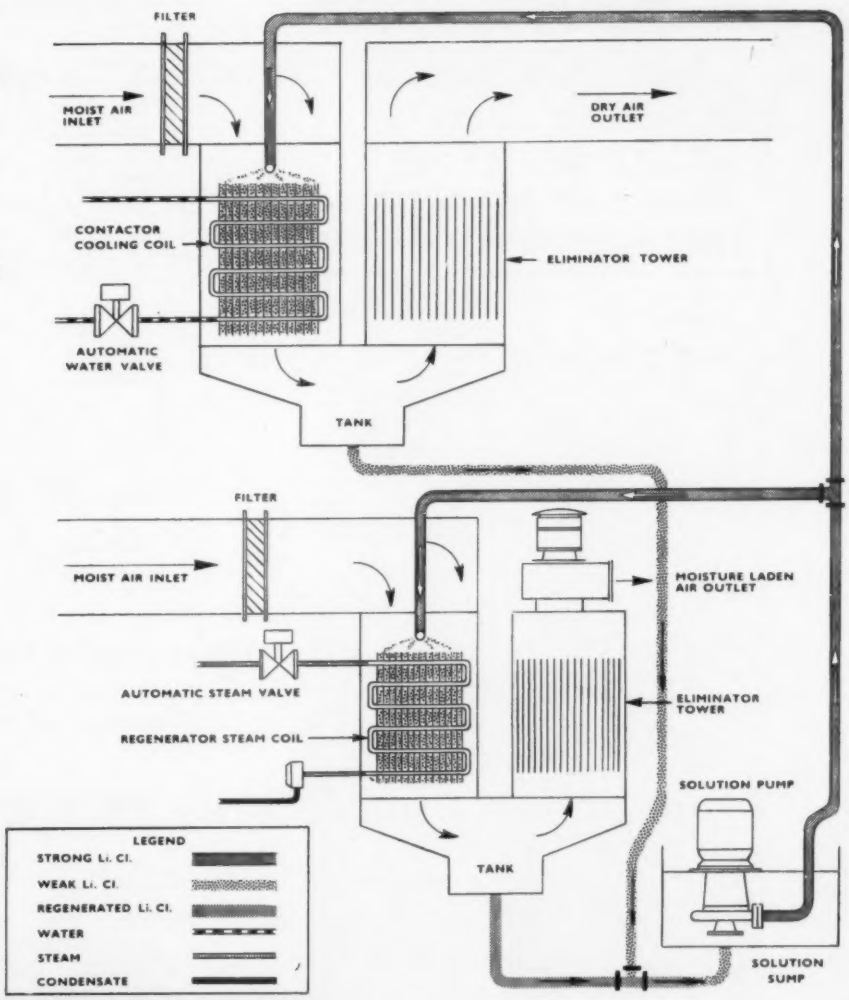

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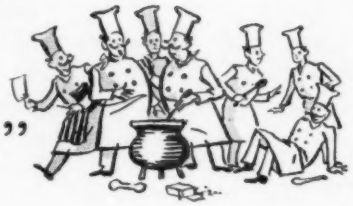
"Too many cooks spoil the broth" 

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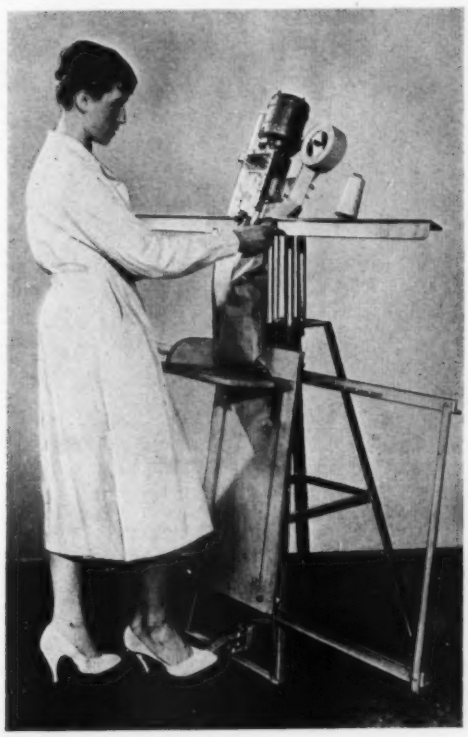

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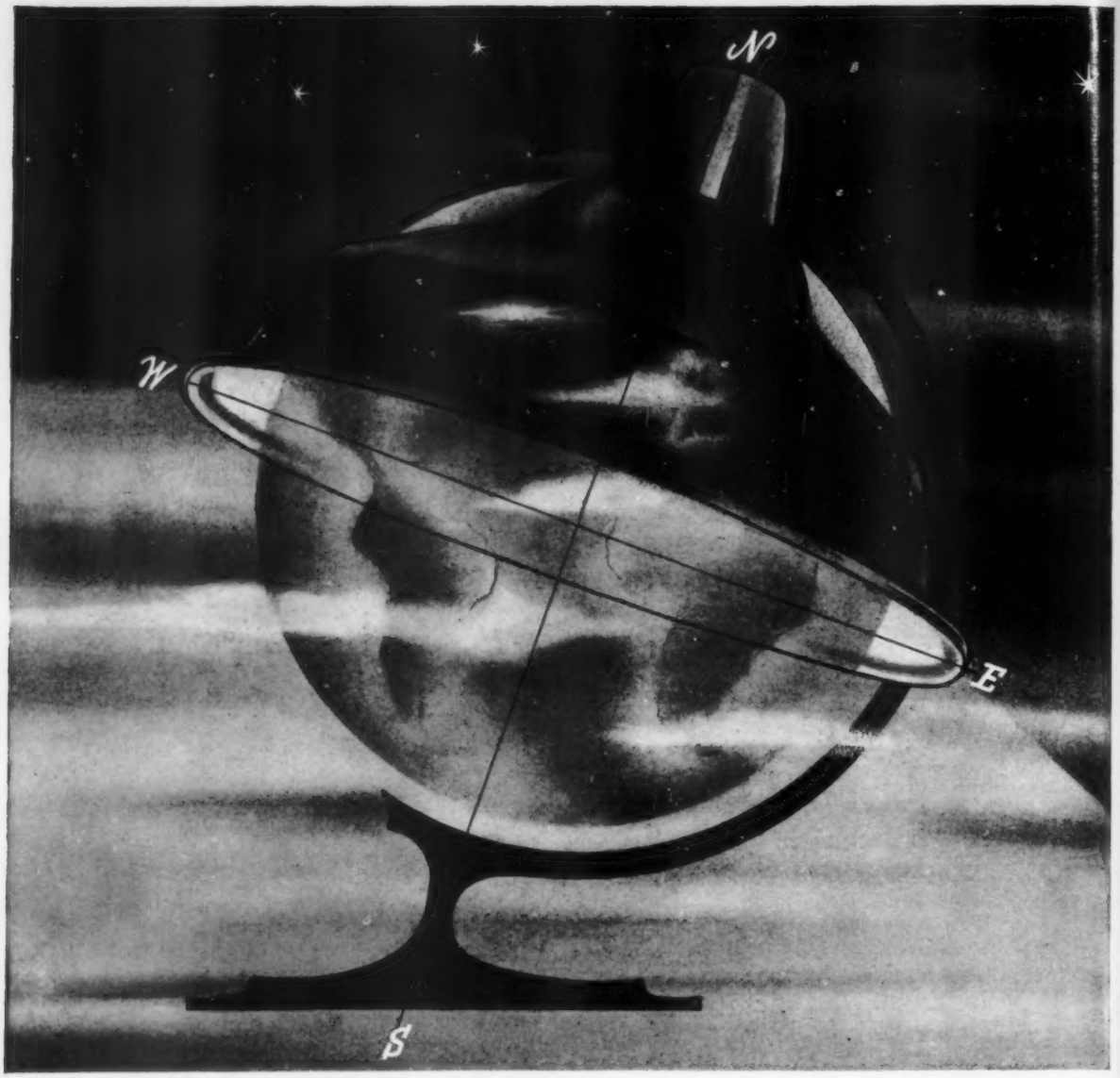

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Further information on I.P.S.1. and I.P.S.2 from:

SHELL CHEMICAL COMPANY LIMITED

In association with Petrochemicals Limited and Styrene Products Limited

Divisional Offices:	LONDON	Norman House, 105-9, Strand, W.C.2. Tel: TEMple Bar 4455.
	MANCHESTER	144-6, Deansgate. Tel: Deansgate 2411.
	BIRMINGHAM	14-20, Corporation Street, 2. Tel: Midland 6954
	GLASGOW	124, St. Vincent Street, C.2. Tel: Central 9561.
	BELFAST	16-20, Rosemary Street. Tel: Belfast 26094.
	DUBLIN	53, Middle Abbey Street. Tel: Dublin 45775.

A set of these advertisements is available free on request from any of the offices listed above.

SA.3

The BEATSON POWDER

Full-automatic production now available in both white flint and amber glass. All main sizes stocked for prompt despatch. Samples and details available on request.

Be sure to specify BEATSON

"The Sign of a TRADE MARK REGISTERED *Good Bottle"*

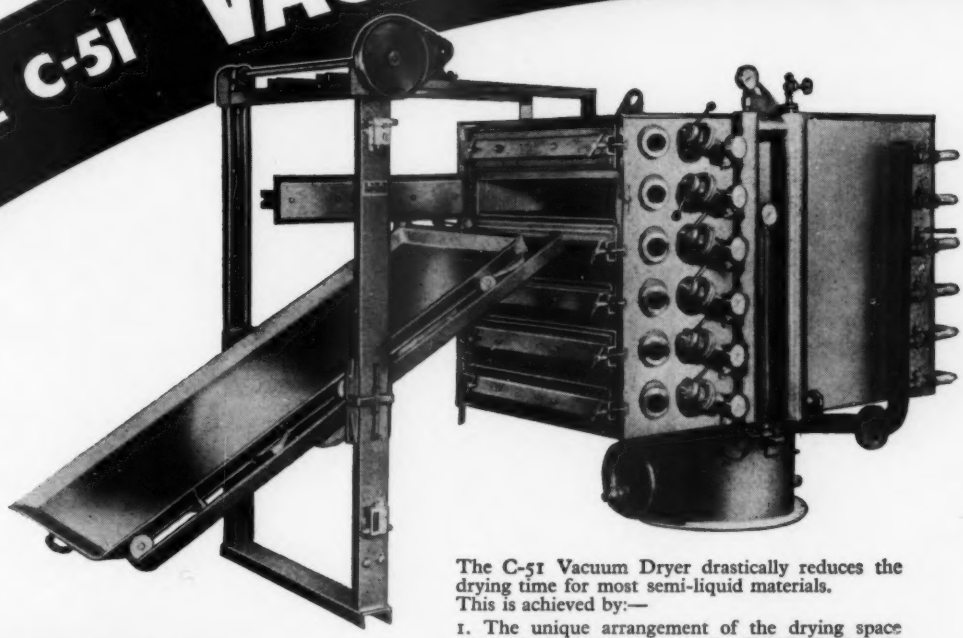
BEATSON, CLARK & CO. LTD., *GLASS BOTTLE MANUFACTURERS*
ROTHERHAM (ESTABLISHED 1751) YORKS

BC. 94

NEW CALMIC VACUUM DRYING SYSTEM

For the rapid, even and safe drying of high moisture content materials·
Pharmaceuticals . Antibiotics·
Veterinary preparations·
Dyes and Pigments·
Precious metals.

THE C-51 VACUUM DRYER



SEMI-CONTINUOUS OPERATION

RAPID, EVEN DRYING

HIGH OUTPUT

LOW TEMPERATURE DRYING

INEXPENSIVE OPERATION

The C-51 Vacuum Dryer drastically reduces the drying time for most semi-liquid materials. This is achieved by:—

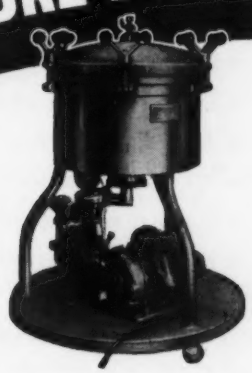
1. The unique arrangement of the drying space which is divided into small, INDEPENDENT compartments which are under vacuum (30 mm Hg absolute) within ONE MINUTE of closing.
2. The patented Vacuum Steam Jacketed trays which transfer the heat directly and evenly to the wet material.

Other important advantages are that the drying can be carried out at low temperatures (for heat sensitive materials) and that the C-51, with its electric elevator and small compartments, can be handled entirely by one man with ease and efficiency. Trays are loaded and unloaded without leaving the elevator and will last indefinitely.

We are always very pleased to advise on individual drying problems. When writing, it will save time if you will let us have the following information:—

1. Highest permissible drying temperature.
2. Initial moisture content.
3. Final moisture content required.
4. Required output of dried material (e.g. per 24 hour day, or per 8 hour day).

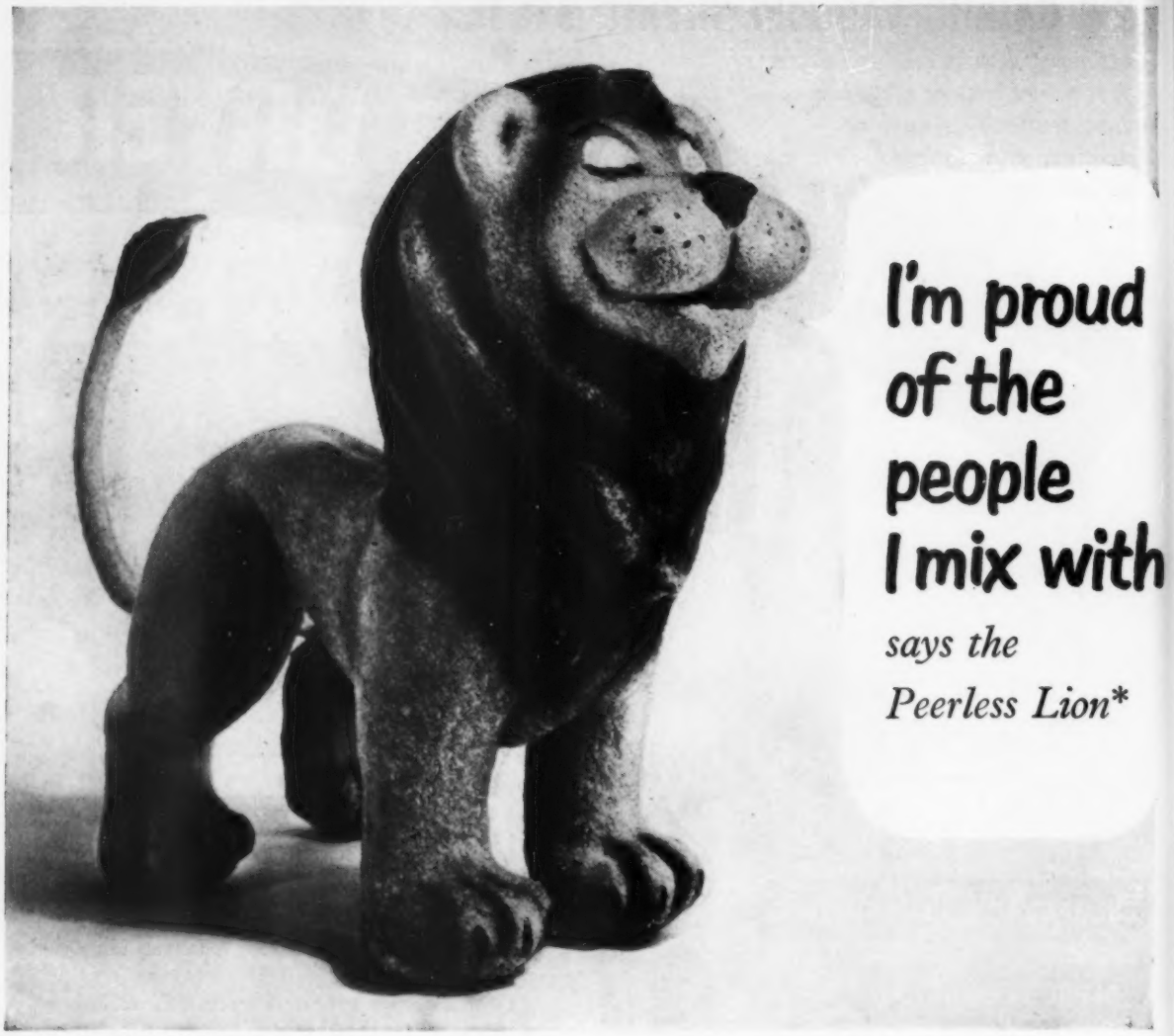
HIGH DUTY PRESSURE FILTERS



Giving constant throughput and high output with ease of dismantling and cleaning.

CALMIC ENGINEERING

CALMIC ENGINEERING CO LTD · Crewe · Cheshire · *CREWE 3251/7*



I'm proud of the people I mix with

*says the Peerless Lion**

May & Baker, the University of Cambridge, British Industrial Plastics, Boots, Monsanto Chemicals, and I.C.I., are just a few of the big names who use Peerless mixers.

- Mixing capacities from 5 litres to 95 litres
- Varying speeds
- Epicyclic mixing action
- Automatic lubrication
- All working parts enclosed
- Stainless steel equipment
- Mixing bowls may be fitted with discharge valves.

If you have an unusually difficult problem, Peerless will develop a special machine to solve it. But probably you will find what you want in the wide Peerless range.

PEERLESS
FOOD MACHINES

Write to us for full technical details

PEERLESS & ERICSSON
Technical Dept., Carlisle Road, The Hyde,
London, N.W.9. Phone: COLindale 8811

Sales and service located in all principal cities

* *The Peerless Lion is the hallmark of perfect mixing*

SPICERS

Carbion *protective sleeving for ethical products*

CARBION is a protective packaging sleeving of considerable interest to the makers of ethical pharmaceutical chemicals.

Manufactured by a patented process, it is an "elasticised" straw paper with remarkable properties of cushioning, crush-resistance and recovery.

These sleeves, within very reasonable tolerance, adjust themselves elastically to form a snug and secure cover, giving a remarkable protection in store and transit to glass bottles and jars, ampoules and stone ware.

This protective cover is easily removed and disposed of when the product is taken into use. No other material is needed to complete the packaging. The sleeve is slipped on and the job is done; consequently, the material and labour is kept to a minimum. As the sleeves pack flat and are versatile in application, the range of stock and storage space before use is also comparatively small.

The Carbion process will also produce rigid case linings and dividers as well as materials combining the functional and the decorative.

May we please arrange for a supply of appropriate-sized sleeves so that you can make a controlled test?

Spicers CARBION

SPICERS LIMITED · CARBION FACTORY · LANGSTON ROAD · LOUGHTON · ESSEX · TEL: LOUGHTON 3638

PLENTY FOR PUMPS and Complete Process Plants

Illustrated is a Plenty Variable Delivery Pump, fitted with air controller and valve positioner to give accurate remote control of flow and pressure.

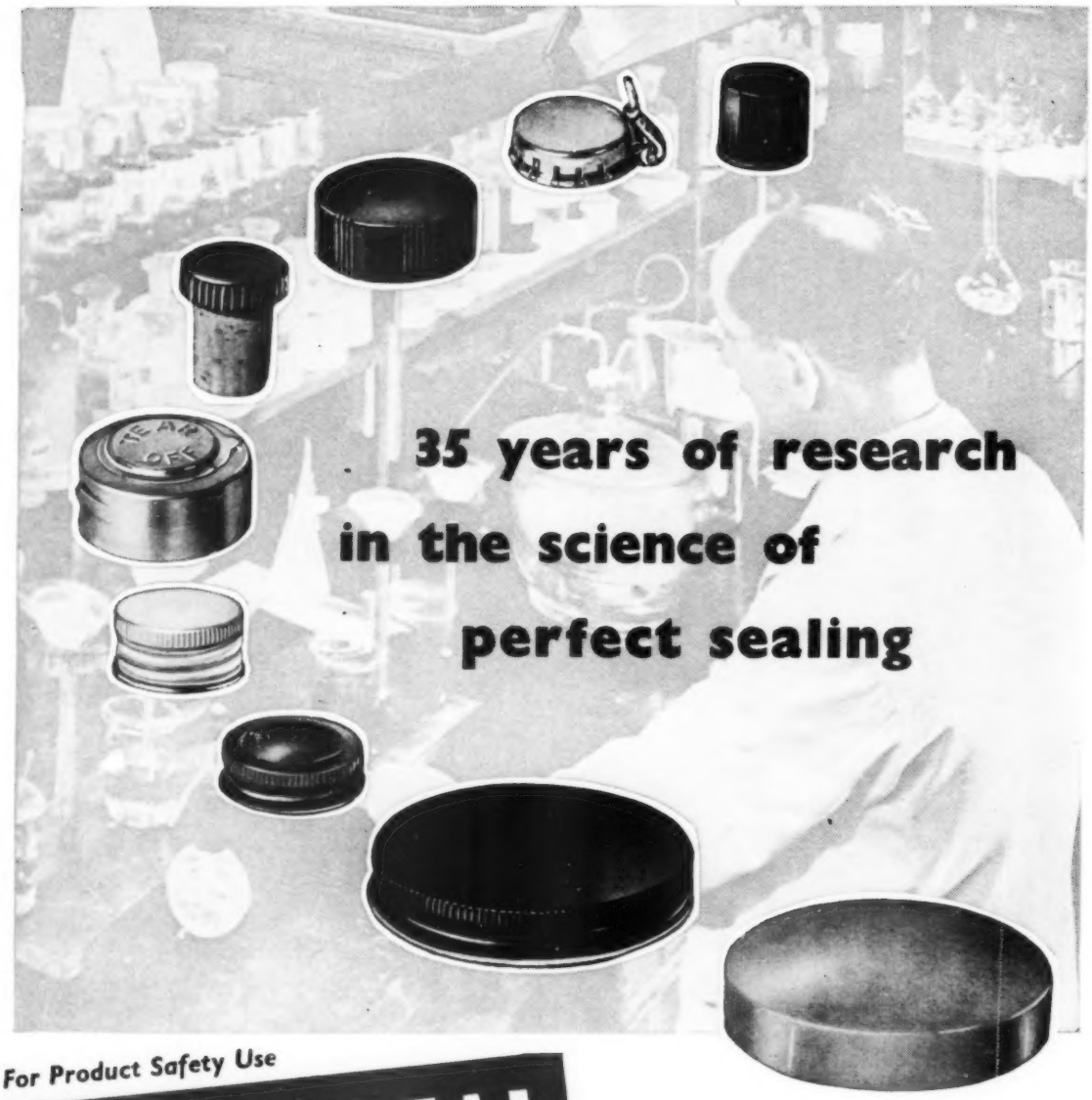
Similar unit supplied to Ewbank & Partners, Shell Refining & Marketing, Central Electricity Generating Board, Procon (G.B.) Thos. Hedley and many others.

PLENTY
& SON Ltd.

Eagle Iron Works,
NEWBURY, Berks.
Telephone: NEWBURY 2363 (4 lines)
Telegrams: PLENTY, NEWBURY

M.C.

NOEL
BUSH
Extend Seasonal Greetings
to All their Friends
J. BUSH & CO · LTD · LONDON · E 8 · ENGLAND · CLI. 1234



For Product Safety Use

KORK-N-SEAL

MOULDED & METAL CLOSURES

WITH UGB GLASS CONTAINERS

UGB CLOSURE DIVISION

KORK-N-SEAL LTD

The Closure Division of The United Glass Bottle Manufacturers Ltd

Head Office: 8 LEICESTER STREET, LONDON, W.C.2 Tel.: GERRARD 8611 (23 lines) Grams.: KORKANSEAL, LESQUARE, LONDON

AA327

REODORIZE

your products and give them

that extra, universal appeal with

*'PLANAROME'

COMPOUNDS

* *trade mark*

'Planarome' compounds are of particular use in the manufacture of adhesives, aerosols, deodorant blocks, disinfectants, inks, paints, perfumed sprays, plastics and rubber.

Samples and further information will be gladly supplied on request

M&B
brand

AROMATIC COMPOUNDS

MANUFACTURED BY

MAY & BAKER LTD

DAGENHAM · TELEPHONE: DOMinion 3060 · EXTENSION: 355

I.C.I. ISOBUTYL ALCOHOL

Supplies of this inexpensive solvent are now available from the new Billingham plant.

isoButyl alcohol can be used in the production of surface coating compositions, to replace the more expensive n-Butanol.

As a solvent, it is also used in the production of pharmaceuticals, fine chemicals, insecticides, and disinfectants. As a chemical intermediate, it is used in the production of esters, plasticizers, and oil additives.

Available in drums or tank wagons.

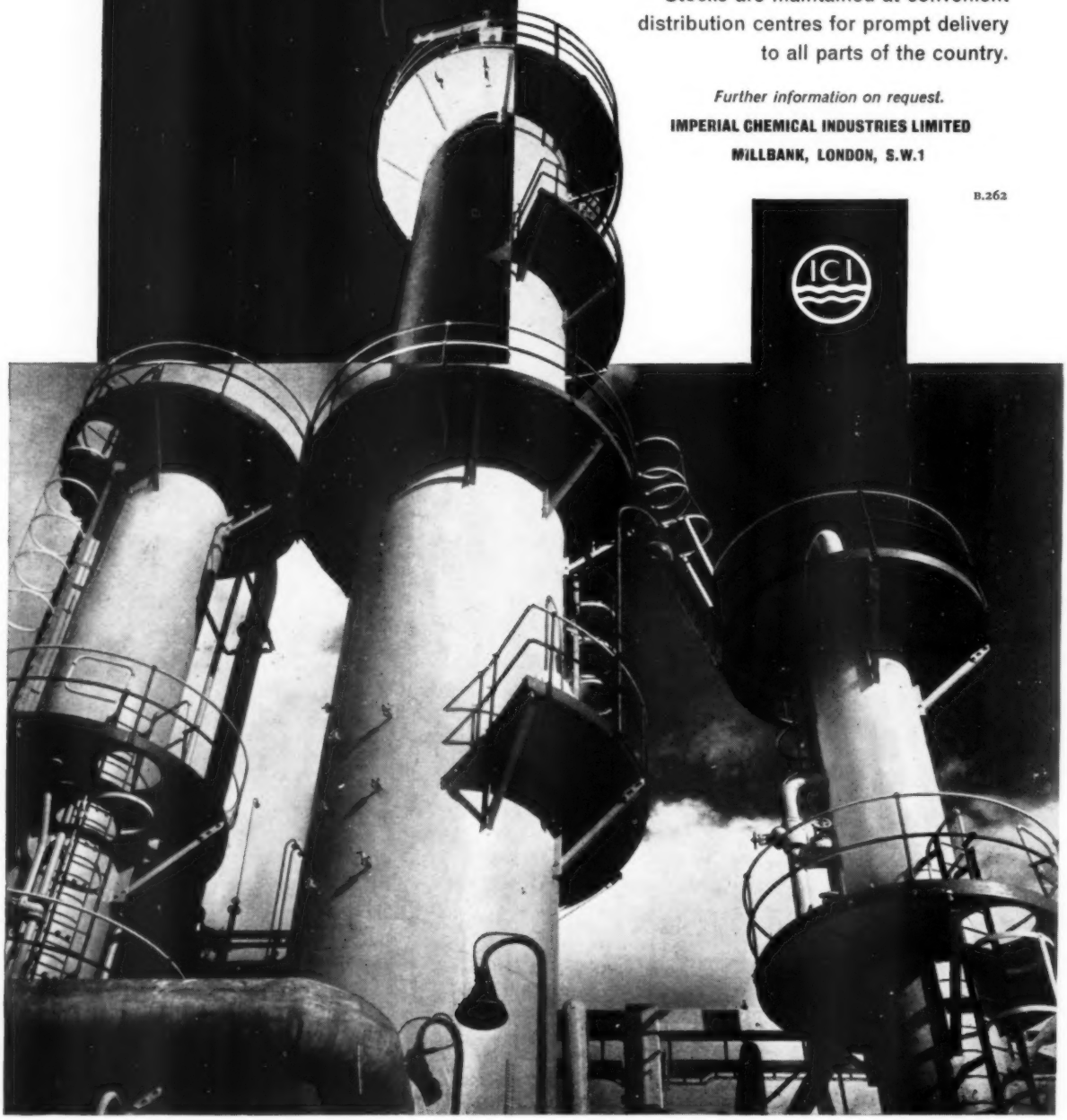
Stocks are maintained at convenient distribution centres for prompt delivery to all parts of the country.

Further information on request.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

MILLBANK, LONDON, S.W.1

B.262

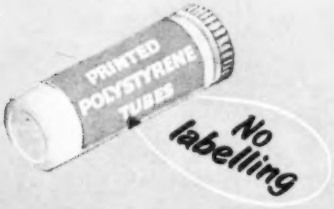


and now—

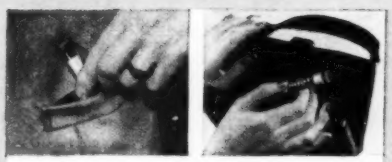
METAL BOX OFFERS

printed

POLYSTYRENE TUBES

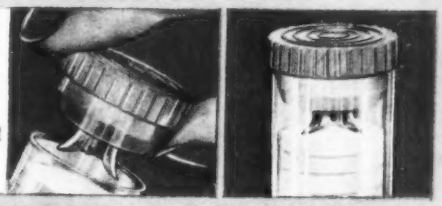


The *colour printed* polystyrene tube is the latest aid to the sale of tablets. Direct printing in two colours on the surface of the tube replaces labelling entirely, and the tube presents an extra smart and attractive appearance on the sales counter. Polystyrene tubes are tough and light. Each is effectively sealed by a one-piece polythene stopper, easy to remove and easy to replace. For additional sales-appeal a wide range of coloured stoppers is available. Please ask today for samples and further details.



Pack your products in containers that will not be left on the bathroom shelf! Metal Box polystyrene tubes are attractive and *specially designed to be carried in the pocket or handbag.*

CUT
THE COST OF
COTTON WOOL!



The Pillar Pack Stopper with the flexible prongs holds tablets gently in place, keeping them undamaged. No cotton wool is needed, no labour to insert it. The tube looks neat, clean and efficient. Pillar Pack Stoppers can be supplied with the $\frac{11}{16}$" × 2$\frac{1}{4}$" tube, and are used by ICI for the Savlon pack featured in the main illustration.

METAL BOX PLASTICS

The Plastics Group of
The Metal Box Company Limited
37 Baker Street, London, W.1.
Hunter 5577

QUALITY

IN WHITE FLINT GLASS CONTAINERS

- *Prompt delivery from stock*
- *Packed in easily handled cartons*

DISPENSING BOTTLES
1-oz. to 20-oz.
RIBBED OVALS
½-oz. to 16-oz
PLAIN OVALS
4-oz., 8-oz. and 16-oz.
BOW-FRONT PANELS
1-oz to 8-oz. and 16-oz.
OLIVE OIL BOTTLES
2½-oz.. 5-oz. and 10-oz.
OVAL TABLET BOTTLES
Nos. 1 to 7½ sizes.
ROUND SCREW JARS
Tall and Semi-squat.
PANEL FLATS
1 oz to 4-oz.
VIALS
½-oz. to 3-oz.
RECTANGULAR TABLET BOTTLES
Nos. 1, 2, 3, 4, 5 and 6 sizes.

★ Amber bottles. We can now offer certain types of Glass Containers in Amber and your enquiries are invited.

NATIONAL GLASS WORKS (YORK) LTD.
FISHERGATE, YORK. Tel. YORK 23021
ALSO AT: 105 HATTON GARDEN, LONDON, E.C.1.
Tel. HOLBORN 2146

TRADE N MARK

WHOLESALE ONLY

Selling Agents in Northern Ireland: Magowan, Vicars (Chemicals) Limited, 64/66 Townsend St., BELFAST. Tel.: Belfast 29830

For high pressure sales

in low pressure aerosols

use **'ARCTON'** propellents

'Arcton' 6, 'Arcton' 9 and 'Arcton' 33—also mixtures of 'Arcton' 6 with 'Arcton' 9 or 'Arcton' 33—the non-toxic, non-inflammable aerosol propellents, are available.

ICI

AR 38

IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1

$N_2 + 3H_2 =$ Ammonia

plus **I.C.I. CATALYSTS** = more Ammonia

32-2 for sulphur removal

22-1 for methane/steam reforming

15-2 for CO conversion

34-4
35-4 } for ammonia synthesis

Full information on request

IMPERIAL CHEMICAL INDUSTRIES LTD
LONDON, S.W.1., ENGLAND

H.8

LET Clarifoil BE YOUR SHOP-WINDOW

Laminates for sachets, window-cartons for stockings and braces, transparent rigid packs for handkerchiefs, blister packs for razors . . . wherever or however crystal-clear Clarifoil is used, it builds its own shop-window round the products. Proved as a sales winner second to none, Clarifoil gives visibility, impact, dominance, and is printable in multi-colours. Pack in tough, water-resistant, flexible Clarifoil to sell, and sell quickly!

Blister Pack by Omega Plastics Ltd.
Sachets by Robinson Waxed Paper Co. Ltd.
Visual Containers by Hargill Ltd. and
Visual Container Co. Ltd.
Window-cartons by J. Dring Ltd. and
E. S. & A. Robinson Ltd.

✳ *The Celanese Technical Sales Service, with its unrivalled experience, is freely available to help solve your packaging problems. Write to Department M.C.4.*

Clarifoil TRADE MARK TRANSPARENT ACETATE FILM *sells on sight!*

Plastics Division · British Celanese Limited · Hanover Square · London W.1 · MAYfair 8000

APB.10.

December Guide to Buyers

• • • • • • • • • • • •

VETYRONE

An interesting speciality with a vetyvert-orris note, capable of imparting pronounced "lift" to modern perfumes.

★ ★ ★

ARTHOL

TRADE MARK.

LIMITED

★ ★ ★

ESSENTIAL OILS
Natural, Synthetic & Terpeneless.

PERFUME ESSENCES
for DEODORISERS etc.

Perfumes

AROMATIC CHEMICALS

TELEGRAMS "SYNTHETICS" CHESTER

SEALAND ROAD
CHESTER

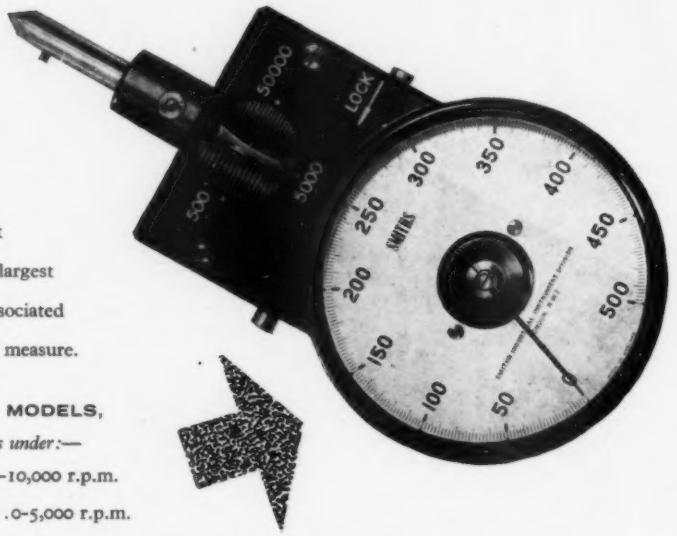
TELEPHONE CHESTER 25664
A.B.C. CODES 5th & 6th EDS

nist

THE STAVELEY IRON & CHEMICAL CO. LTD. NR. CHESTERFIELD

SMITHS for Good Measure

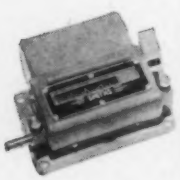
By and large, Industry depends on SMITHS for good measure, both literally and metaphorically. Literally, for the robustness and long-term accuracy of their wide range of industrial instruments; metaphorically, for the service potential constituted by the unrivalled research and test facilities of an organisation which is Britain's largest manufacturer of industrial instruments and associated equipment. Such potential, is, indeed, beyond measure.



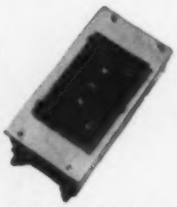
AVAILABLE IN CHOICE OF FOUR MODELS,

each complete with case and accessories, as under:—

A.T.H.4. .0-50,000 r.p.m. (illustrated)
A.T.H.6. .0-10,000 r.p.m.
A.T.H.7. .0-20,000 r.p.m.
A.T.H.10. .0-5,000 r.p.m.



Predetermined Counters for counting predetermined quantities.

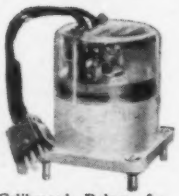


Transistor Batch Counters for high speed counting of repetitive quantities.

Electric Tachometers a.c., d.c. & Three Phase.

"Petro-flex" Flexible Tubing.

Synchronous Hours Counters for indicating life of equipment in a.c. circuits.



Calibrated Relays for the control of voltage, current and speed.

Examples of

SMITHS

Good measure

HAND TACHOMETERS

Provide an accurate method of making spot checks of:–

ROTATIONAL SPEEDS—Shafts, spindles, gears, rotors and rolls.

LINEAL SPEEDS (ft/min or metres/min)—Metal strips, textiles, paper, wire, plastic film and conveyed material.

SURFACE SPEEDS (ft/min, metres/min). Cutting and grinding operations of machine tools, processing rolls, unwind rolls or wind-up rolls for extrusion and strip production.

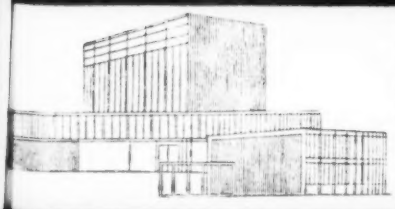
Readings can be taken in bad light or where the dial is visually obscured by using the extension shaft supplied.

Write for individual leaflets

SMITHS INDUSTRIAL INSTRUMENT DIVISION

Chronos Works, North Circular Road, London, N.W.2. Telephone: GLAdstone 1136

AP 188/370

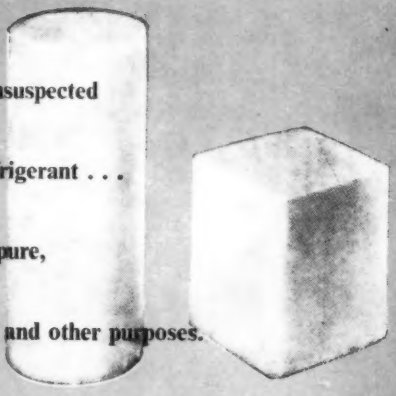


Polak & Schwarz's new chemical factory recently opened at Haverhill, Suffolk The P. & S. organisation, which now has 18 associated companies throughout the world has, during the last 69 years, attained wide experience in the field of aromatic chemicals.

POLAK & SCHWARZ (ENGLAND) LTD.

50 Great Cambridge Road, Enfield (Middlesex) Telephone: Enfield 6781. Telex: London 2641

'Drikold'—solid carbon dioxide—is a product of unsuspected versatility. It is best known as a convenient, non-messy refrigerant . . . When vaporised in the 'Drikold' Liquefier, it yields pure, very dry carbon dioxide suitable for a multitude of chemical and other purposes.



'Drikold'

serves the chemical industry

As refrigerant

—'DRIKOLD' *is ideal* for the cold grinding of gummy or heat-sensitive materials: for freeze-drying heat-sensitive products and for their refrigerated transport; for improving yields from crystallisation processes, and regenerating electroplating solutions; for numerous laboratory processes requiring low temperatures.

As reagent

—'DRIKOLD' *is a convenient source of carbon dioxide* for the production of carbonates, carbamates, salicylates, etc.; for use as a cheap acid in pH control, for the 'springing' of phenols, in sugar-refining, for stabilising lime-softened water supplies.

As inert gas

—'DRIKOLD' *used in the* 'DRIKOLD' *Liquefier, is a convenient source of pure, dry carbon dioxide gas* for blanketing process operations in which there is a serious fire-hazard; for maintaining an inert or non-oxidising atmosphere in reaction processes, in stills, and in storage tanks and containers; for fire-fighting.

'Drikold' is the registered trade name of the solid carbon dioxide made and marketed by Imperial Chemical Industries Ltd.

Full information on request.

Imperial Chemical Industries Ltd., London, S.W.1.

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Personal attention

and unrivalled service

METALLICHO LTD.

LLANTARNAM ROAD, CWMBRAN, MON.

Telephone: CWMBRAN 31

Manufacturers of quality decorated tins

at competitive prices

Homogenisation?

e.g.

Product	high viscosity water in oil emulsion
Throughput	300 gallons per hour
Power	2 hp maximum
Location	wooden floor with weight limit
Labour	only unskilled available
Quality control	no air in product, fine, even particle size imperative, sterile
Budget	£300

Answer The **Rapisonic** Homogenizer takes such jobs in its stride. Draw upon specialist experience and get full details of machines for your production

Ultrasonics Ltd
Westgate
Otley
Yorkshire

Amphionics

New and Interesting Classes of AMPHOLYTIC Surface Active Agents

Ambiterics

. . . combining the properties of anionics and cationics for the

formulation of **GERMICIDES / DETERGENTS / SANITISERS / PHARMACEUTICAL PREPARATIONS**

Samples available for evaluation

GLOVERS

(CHEMICALS) LIMITED

GCL

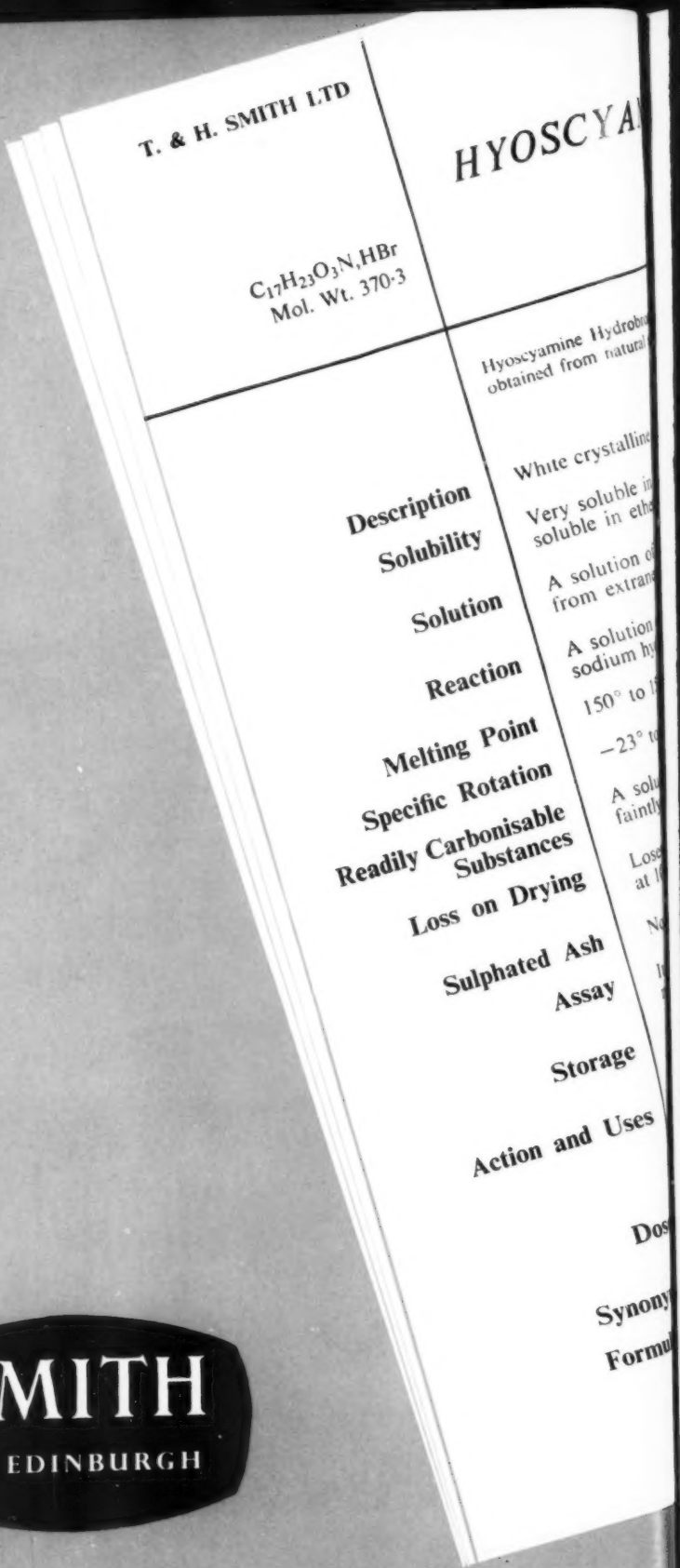
WORTLEY LOW MILLS, LEEDS 12. Tel: LEEDS 63-7847/8/9 Grams: "GLOKEM Leeds"

ALKALOIDS

and allied products

Specification sheets for each of the products listed are available on request.

ARECOLINE HYDROBROMIDE
ATROPINE METHONITRATE
ATROPINE SULPHATE
CAFFEINE CITRATE
CANTHARIDIN
CODEINE PHOSPHATE
COLCHICINE SALICYLATE
ESERINE SALICYLATE
ESERINE SULPHATE
HOMATROPINE ALKALOID
HOMATROPINE HYDROBROMIDE
HOMATROPINE HYDROCHLORIDE
HOMATROPINE METHYLBROMIDE
HYOSCINE HYDROBROMIDE
HYOSCINE METHYLBROMIDE
HYOSCYAMINE ALKALOID
HYOSCYAMINE HYDROBROMIDE
HYOSCYAMINE HYDROCHLORIDE
HYOSCYAMINE SULPHATE
MORPHINE SULPHATE
PICROTOXIN
PILOCARPINE HYDROCHLORIDE
PILOCARPINE NITRATE
SALICIN
SANTONIN
STRYCHNINE ALKALOID
STRYCHNINE HYDROCHLORIDE
STRYCHNINE SULPHATE


T. & H. SMITH LTD

$C_{17}H_{23}O_3N,HBr$
Mol. Wt. 370·3

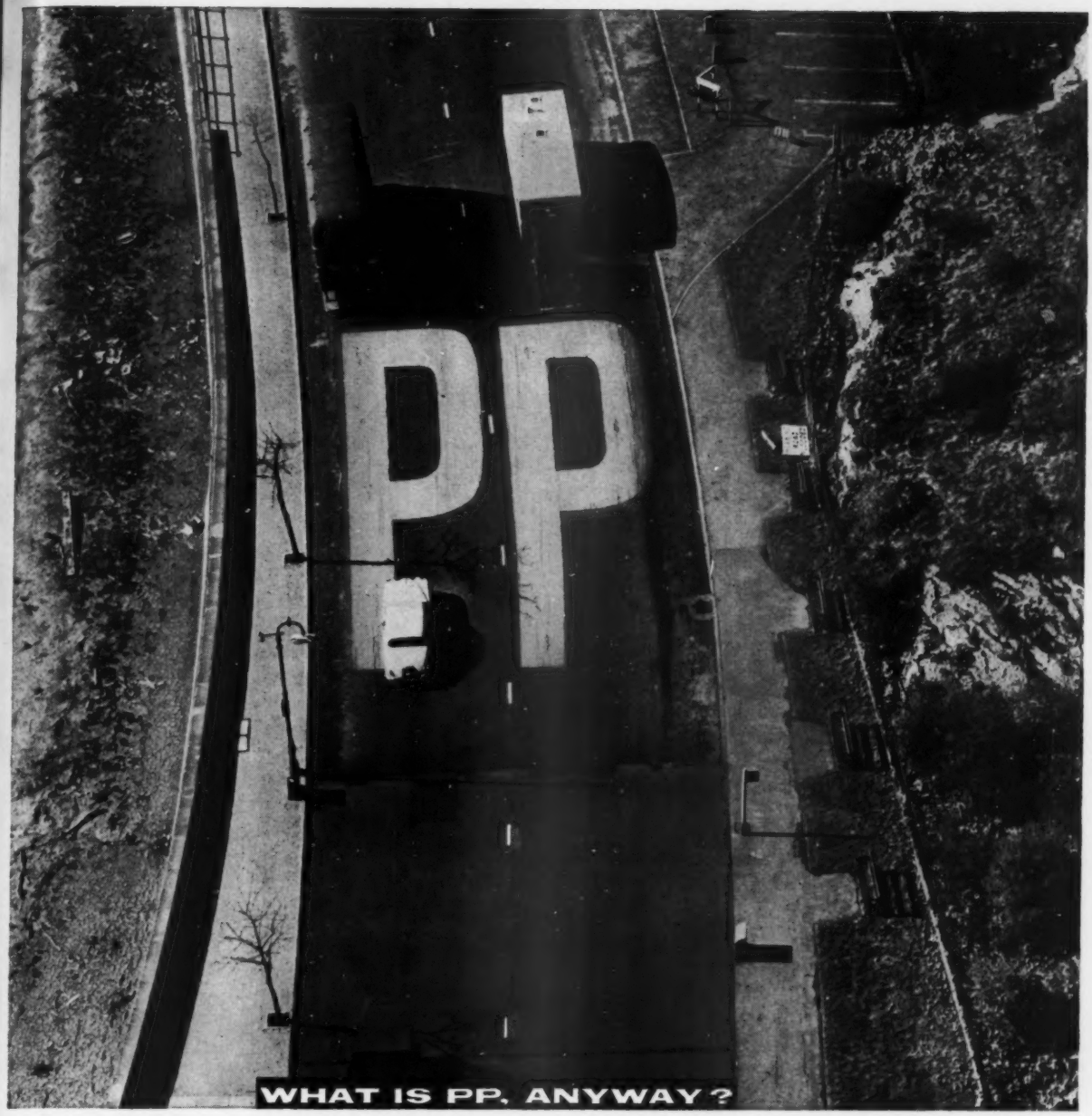
HYOSCYA

Hyoscyamine Hydrobr
obtained from natural

Description	White crystalline
Solubility	Very soluble in soluble in ethe
Solution	A solution o from extrane
Reaction	A solution sodium hy
Melting Point	150° to 1
Specific Rotation	−23° to
Readily Carbonisable Substances	A solu faintly
Loss on Drying	Loss at 1
Sulphated Ash	No
Assay	
Storage	
Action and Uses	
Dos	
Synony	
Formu	

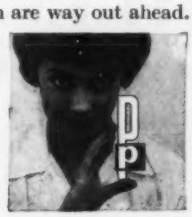
SMITH
OF EDINBURGH

T. & H. SMITH LTD BLANDFIELD CHEMICAL WORKS EDINBURGH 11



You come across it wherever you go—Progressive Packaging indicating the short route to soaring sales. Your packaging *must* be progressive—the best and most suitable of transparent materials, the most brilliant printing techniques, and ideas which are way out ahead.

For *your* PP **... call in**



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COLODENSE LTD · WEST STREET · BRISTOL 3 · TEL: 63015

for ALL ENGINEERING SUPPLIES –

COCKS, VALVES
GAUGES, ETC.
PACKINGS, JOINTINGS
BELTINGS, VEE ROPES
OILS AND GREASES
HOSES AND FITTINGS
ETC., ETC.

HOP
8022
25 lines

LARGE STOCKS ~ KEEN PRICES

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W.H.WILLCOX & CO. LTD.

SOUTHWARK STREET, LONDON, S.E.1

We're old hands at making petroleum sulphonates

sulphonates for emulsifiers 1940

1940 *sulphonates for cutting oils*

sulphonates for anti-corrosive compounds 1940

1941 *sulphonics for fat-splitting agents*

sulphonates for ore flotation 1945

1946 *sulphonates for agricultural sprays*

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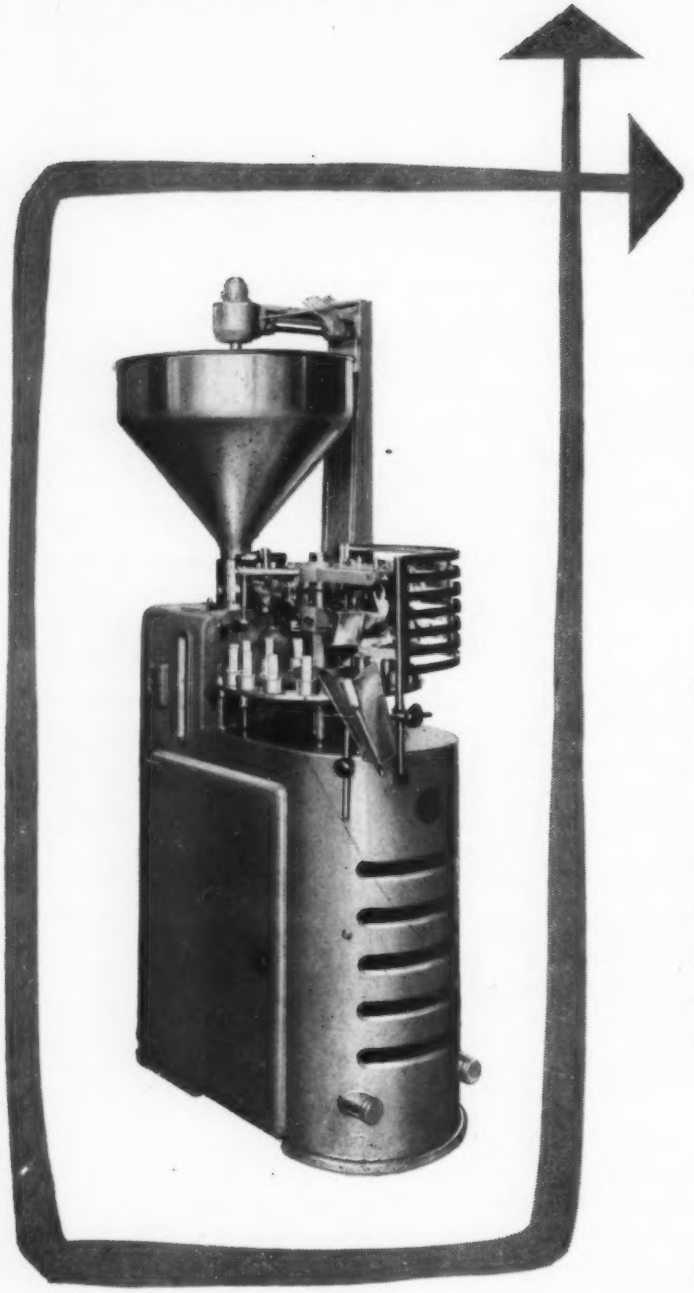

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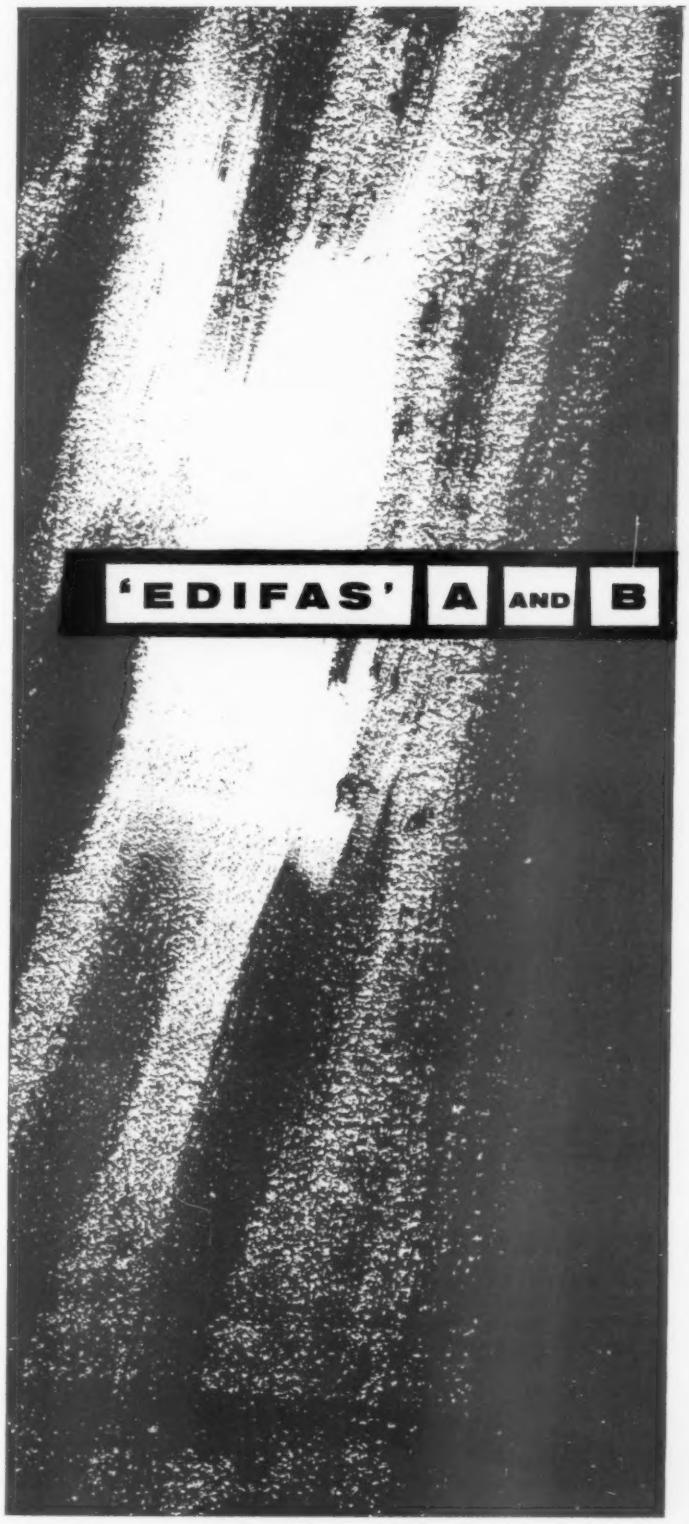

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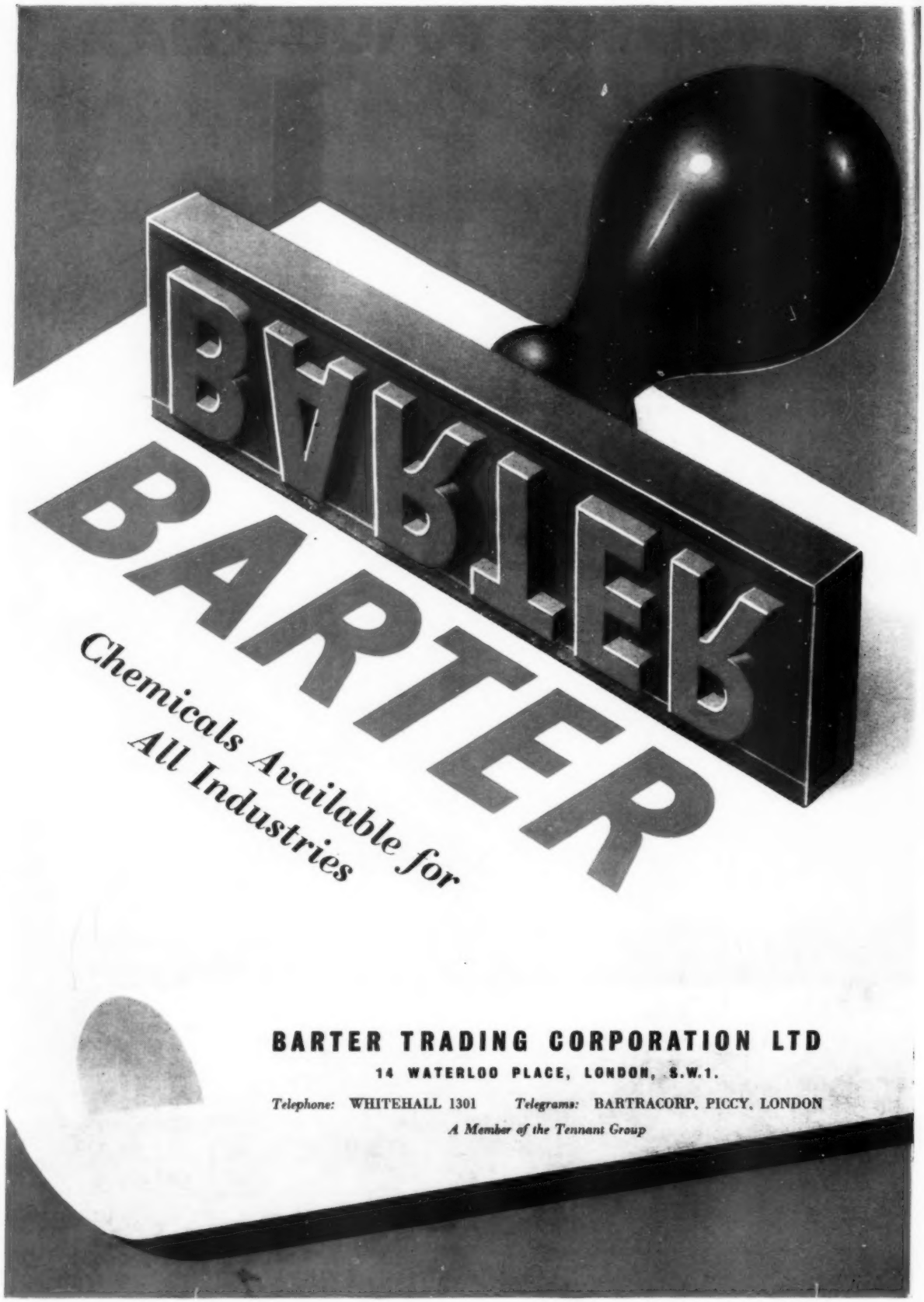
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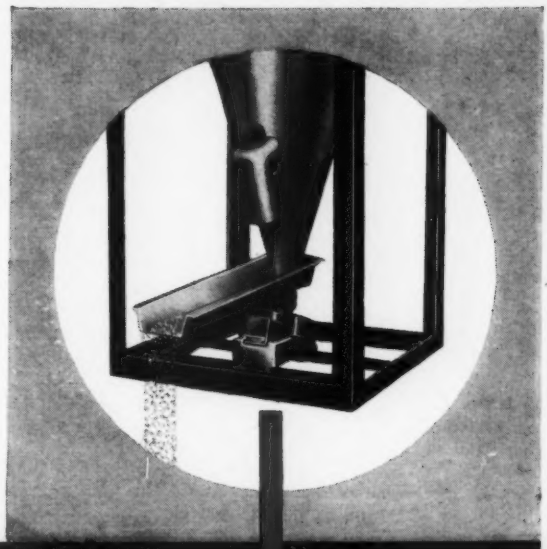

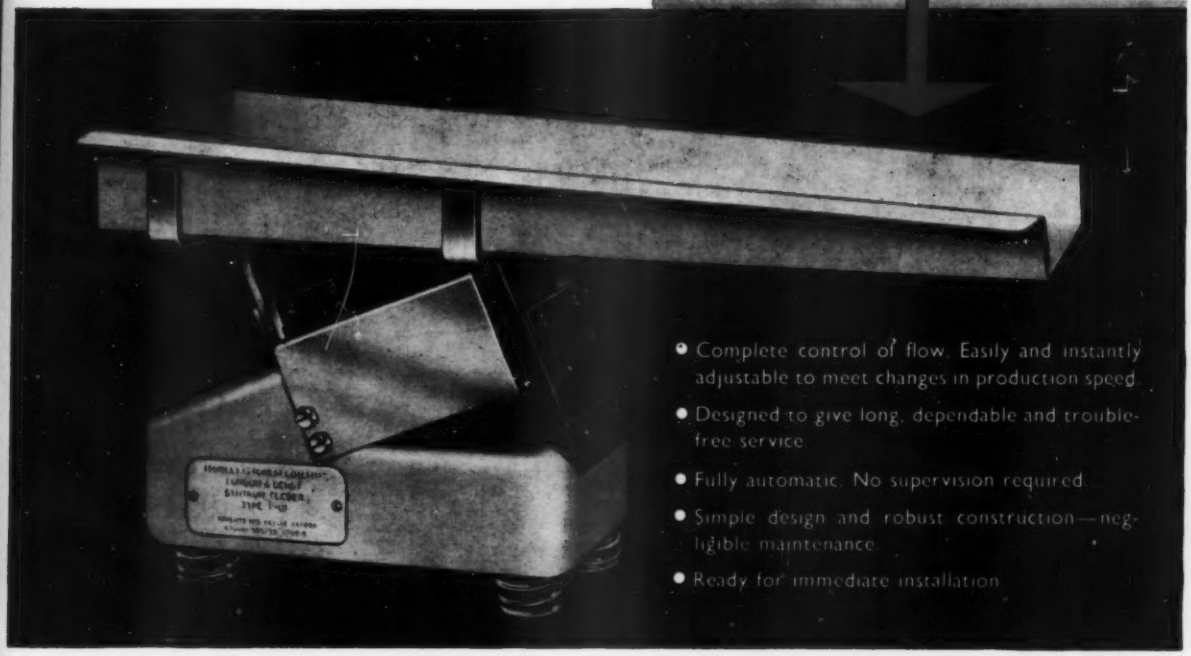

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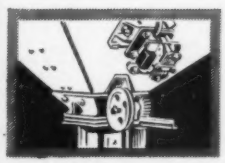

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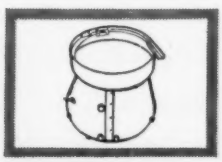

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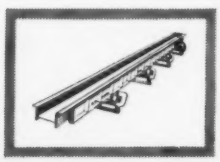

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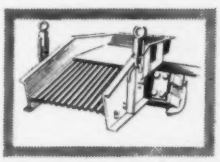

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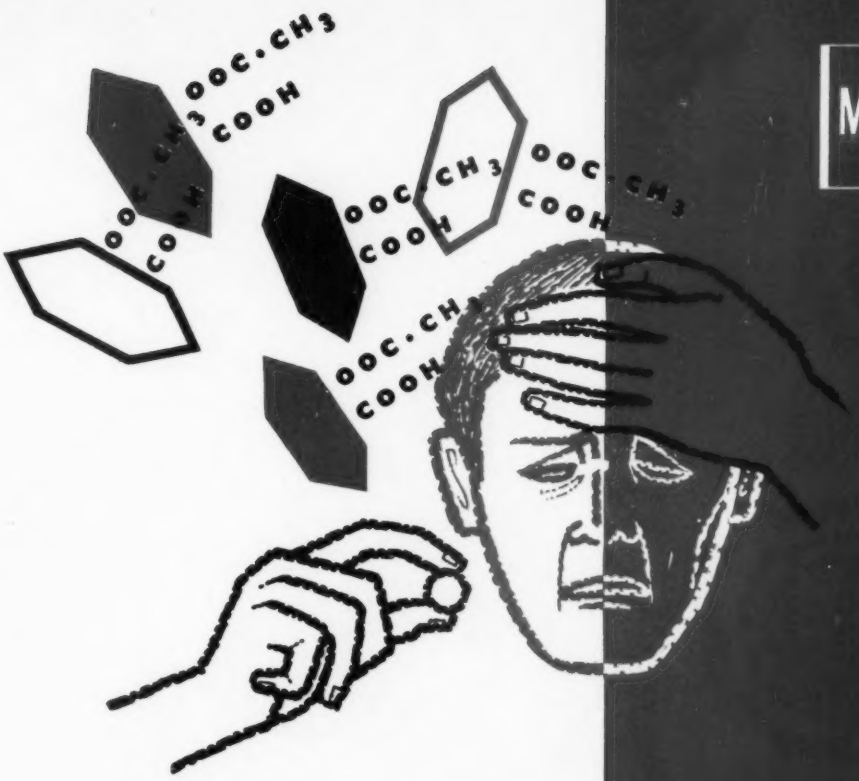

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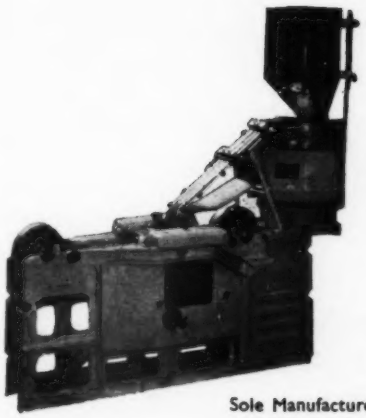

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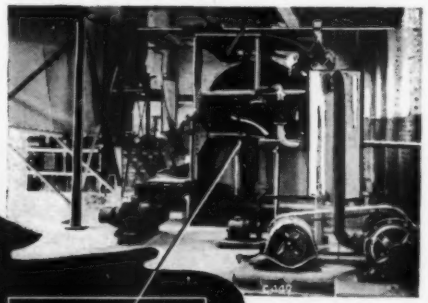

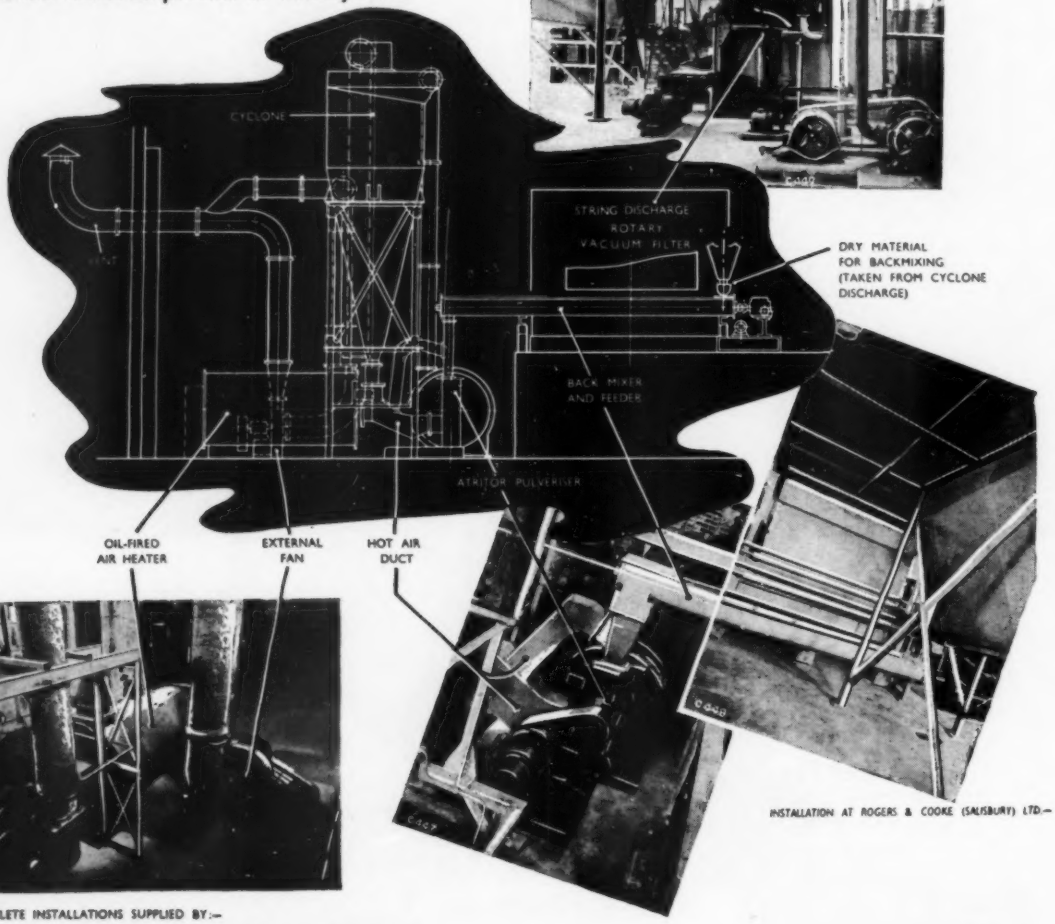

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Vol. XXIX, No. 12 — DECEMBER, 1958

Contents

Topics and Comments: 499
Hard times; Criticism; Microbiology at Teddington; Computer as chemical engineer; Anti-leprosy ointment; " Atomic World "; No more nationalisation; Reps are welcome.

Wyeth's New Research Laboratories 503

Exceeding Small 505

Size Reduction Machinery 509

Veterinary Antibiotic Preparations 513
By G. N. Henderson, B.SC., *and C. F. Abbott*, B.PHARM.

Recent Developments in Gas Chromatography—2 517
By R. P. W. Scott, B.SC., F.R.I.C.

Progress Reports:

Antibiotics 523
By R. Levin, F.P.S.

Analytical Chemistry 526
By William I. Stephen, PH.D., A.R.I.C.

Detergents and Detergency 529
By Leon Raphael, M.SC., F.R.I.C.

Index for 1958 543

REGULAR FEATURES: BOOK REVIEWS 532 • PLANT AND EQUIPMENT 533 • NEWS 535 • PEOPLE 537 NEWS FROM ABROAD 538 • NEW PRODUCTS 539 • PACKAGING 539 • CORRESPONDENCE 539 CHEMICAL MARKET 540 • NEW TRADE MARKS 542 • NEW PATENTS 542 • NEW COMPANIES 542 SIXTY YEARS AGO 542

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TOPICS AND COMMENTS

Hard times

WHEN a well-managed and highly successful company like Glaxo Laboratories Ltd. starts complaining about competition to the extent of doubting whether its profits can be maintained, it can be taken that the industry generally is feeling the pinch. Two-thirds of Glaxo's turnover comes from sales abroad either from exports or from the sales of overseas manufacturing subsidiaries. In the past year sales have declined because the prices of basic commodities have come down and foreign countries' earnings have declined. As a big buyer of raw materials on the world markets Britain may well rejoice when prices fall. But we cannot have it both ways. If the foreign seller's earnings are cut the foreign buyer's purchasing power is likewise reduced, even to the extent of compelling him to curtail purchases of necessities like drugs and medicines. Political turmoil in the Middle and Far East has also sapped confidence.

Another consequence of shortage of foreign exchange is that overseas customers feel increasingly compelled to set up their own secondary industries, including the manufacture of pharmaceuticals. The only way British firms can meet this problem is to set up factories themselves in the countries concerned. Glaxo, in the past year, have established factories in Ceylon and Colombia, bringing the total of their overseas factories to 12. Another means of meeting local demand for factories is to win contracts for the development of national pharmaceutical industries. Evans Medical have done this in Burma, and Allen and Hanburys, now amalgamated with Glaxo, have just won a £1 million contract to set up a pharmaceutical industry for the Iranian Government near Teheran. No doubt other British companies will seek similar contracts in other countries. While the firms concerned must be congratulated on their initiative, such developments can only result in reducing the activity of their home factories engaged on producing for export. In the long run, as living standards rise, demand is bound to increase, but it behoves every firm to exercise the utmost flexibility in meeting changing conditions.

On the home market, of course, British firms are facing the problem of immigrant manufacturers, particularly American. As we pointed out in the article " Dollar Technology in Britain " (September, p. 365), of 24 manufacturers of ethicals in Britain 13 are American. In his annual statement to Glaxo shareholders, Sir Harry Jephcott says: " Recent indications that the importation of dollar chemicals are to be progressively removed, and renewed efforts to bring into being some form of European free trade, suggest that competition from overseas may be intensified."

Criticism

IN VIEW of the fundamental importance of the home market to the British pharmaceutical industry in providing the solid basis for overseas sales, it is extremely discouraging to have to face constant complaints about the Health Service drug bill. In this context, another quotation from Sir Harry Jephcott's statement is illuminating. " Critics who single out the selling and pricing policies of the pharmaceutical companies for attack fail to understand our problems and accomplishments. For example, during the past ten years rates of wages paid to our employees in this country have risen by well over 50% and the prices paid for our raw materials have risen by over 25%. In the same period not one of our pharmaceutical or antibiotic preparations has been increased in price. Indeed a customer purchasing a representative group of these products today would pay little more than one-half the price he would have paid ten years ago. Such an achievement is, I would suggest, probably unparalleled in any other branch of industry."

Another ignorant criticism concerns the use of proprietary names. Confusing as they may be to the tidy minds of the planners, they have hard commercial value and are indispensable in sustaining and increasing export sales. Proprietary names happen to be the basis of pharmaceutical exporting, and whether the planners like it or not that is the way we earn a good deal of foreign exchange. Deprive us of the ability to earn foreign exchange and soon there will be nothing left in this country to plan.

Microbiology at Teddington

WE UNDERSTAND that one of the victims of the current reorganisation of the Department of Scientific and Industrial Research is likely to be the Microbiology Group of the National Chemical Laboratory at Teddington. The fate of this section is being considered by the Council of the D.S.I.R. as we go to press. One of the recommendations from the N.C.L. Steering Committee which the Council will be considering is that the research section of the Microbiology Group should be disbanded.

The microbiological organisation at Teddington arose from a small laboratory set up at the Royal Naval Cordite Factory in connection with the Weizmann acetone fermentation process developed during World War 1. This process gave very erratic results until strict bacteriological control was enforced at all stages; it then ran quite smoothly, but this particular plant soon ceased production owing to shortage of the raw materials required.

After the war the control laboratory was taken over by the then newly formed D.S.I.R. for general bacteriological purposes, and carried out various investigations of bacterial fermentations, on decay of textiles, etc.

Some time in the 1930's the bacteriology laboratory was transferred to London, but lost much of its authority through being demoted to become a section of the Department's chemistry laboratories. Its work became restricted to a few specific problems of no urgent importance to industry as a whole—notably the revival of "food yeast," and an exhaustive study of the sulphate reducing bacteria. Meanwhile, other microbiological problems formed an increasing part of the work of other departments such as the Forest Products Laboratory and the Low Temperature Research Station, and of the part-subsidised research associations.

It is interesting to turn back, after 35 years, to the report* of a joint meeting held in 1923 by the Society of Chemical Industry and the Biochemical Society. The brewing consultant Mr. A. Chaston Chapman proposed the formation of a central institution for industrial microbiology—to act as a clearing house, a centre for research and training, and to maintain a culture collection. The remarks of some of the eminent chemists present (if correctly reported) sound very naïve to modern ears. Sir William Pope supported the suggestion, and said that " . . . the chemical operations of the organism belonged to pure organic chemistry, and that the living matter was, in a manner merely an accompaniment; in fact all the chemical concomitants of biology belonged to organic chemistry considered purely as a laboratory science, and the only real puzzle connected with the study of living matter was associated with the problem of growth."

Prof. H. E. Armstrong—possibly with his tongue in his cheek—strongly opposed the motion, and considered that the proposed objects were " . . . work for highly trained chemists beyond the bacteriophile." Never were the dangers of making one science subordinate to another more glaringly illustrated.

There is a great deal to be said for the view that long-range team work problems are best left to the universities and to industry, and that the more acceptable function of *official* scientific institutes is to act as clearing houses for the collection, critical examination, and dissemination of information in their particular field. The staff need not be large, but must be of a high standard in knowledge and experience. A shining example of an organisation of this type is the Commonwealth Mycological Institute at Kew, concerned primarily but not exclusively with the fungi parasitic on crop plants. This institution has established its usefulness so effectively that one cannot imagine its being closed down without provoking a storm of protests from all quarters. There would seem to be ample scope for the establishment of a similar institute to cover the multifarious applications of microbiology to industry.

* *J. Soc. Chem. Ind.*, 1923, pp. 169T–180T.

Computer as chemical engineer

It is now possible to solve start-up and operating problems of a chemical plant before the plant is completed by means of an analogue computer. The efficacy of this new aid for the chemical engineer was demonstrated during the design of the hydrogen peroxide plant which Laporte Chemicals Ltd. have just started up at their Baronet Works, Warrington. The plant and process are completely new. Hydrogen peroxide is made by a cyclic process involving the autoxidation of 2-ethyl anthraquinol to yield 2-ethyl anthraquinone and H_2O_2. The anthraquinone is then catalytically hydrogenated to the anthraquinol which is fed back into the process and recycled. The process is both more productive and more economical than the electrolytic process and will substantially increase Laporte's output of hydrogen peroxide, enabling them to meet large military demands for rocket fuel oxidant and also the growing industrial demands for H_2O_2 for such uses as the manufacture of oxygenated compounds for detergent manufacture. We shall publish more details of the plant and process in our next issue.

The analogue computer project was a joint venture between Laporte's engineers and the computer experts of E.M.I. Ltd. The plant is heavily instrumented and includes surge tanks, reaction vessels and a 24-plate extraction column (for separating hydrogen peroxide from the solution of 2-ethyl anthraquinone) in a closed system with seven subsidiary loops. The information required from the computer study included: 1. confirmation that the capacities of the various vessels would be sufficient for all expected major flow changes (including start-up and shut-down conditions); 2. the determination of optimum control settings of the automatic controllers; 3. confirmation that no interaction, which might cause sustained hunting, would occur between various vessels and controllers in the plant; 4. determination of any points of particular sensitivity to oscillatory disturbances.

The flow of liquids round the circuit was represented by a series of 31 equations of varying degrees of complexity. These equations represented conditions controlling the flow at all points in the plant, and took into consideration such factors as the capacity of vessels, friction drop in pipelines and heat exchangers, flow characteristics of control valves, pump characteristics and response characteristics for the automatic controllers themselves. When this information was fed into the Emiac analogue computer it was arranged so that recorders could be plugged in to measure flows, pressures, heights, etc., in many parts of the plant, and the behaviour of the plant as a whole determined. The time scale was compressed by a factor

of 60 and one second on the computer represented one minute of real time on the plant.

This investigation enabled design work to be completed with confidence that no major mistakes had been made either in vessel capacities or in the arrangement of the controller systems. It has not been possible as yet to determine the degree of accuracy of the figures which resulted from the computer as far as plant response times are concerned, but as the plant did not, in fact, give any unexpected trouble during start-up it is believed that the numerical information is at least reasonably accurate. The cost of the study—which took two months—was less than £3,000. The total cost of the plant, including initial supplies of raw materials, amounted to £2,500,000.

Anti-leprosy ointment

A REMARKABLE feature of the new I.C.I. anti-leprosy drug *Etisul* is that it is administered by rubbing on the skin. This must surely be the only example in modern medicine of a drug which can exert its effect throughout the body *via* inunction. Apart from the ease with which it can be administered it gives the leper the psychological satisfaction of being able to put something on the affected parts of his body. He does not necessarily know, nor need he, that the drug releases its activity throughout his body.

The active agent of *Etisul* is ethyl mercaptan, a distasteful and evil-smelling substance which would pose many problems if it had to be taken by mouth, owing to the risk of the formulation breaking down and releasing ethyl mercaptan. So, from all standpoints, it is fortunate that the drug (chemically diethyl dithiol isophthalate) can be administered as an ointment.

The discovery of the anti-leprosy effects of ethyl mercaptan arose from a study by I.C.I. workers of the experiments of an Italian chemist, Del Pianto, with synthetic compounds against tuberculosis. They found that ethyl mercaptan was the active agent and spent several years testing over 400 different compounds against experimental tuberculosis in animals. (Human leprosy cannot be reproduced in animals, but tuberculosis gives a useful indirect test for an anti-leprosy drug.) Eventually a compound was found which proved highly active against the form of leprosy that occurs in rodents. The next stage of development was the selection of the ointment or cream base most suitable for carrying the drug and the careful manipulation of ingredients, including perfume, to mask the smell of ethyl mercaptan which is liberated in small amounts when the ointment is applied.

Since April last year *Etisul* has been clinically tested at the Nigerian Leprosy Service Research Unit at Uzuakoli, Eastern Nigeria, by Dr. T. F. Davey, head of the unit. At the 7th International Congress on Leprology in Tokyo, Dr. Davey said that it is hoped *Etisul* will reduce appreciably the time a patient spends in a leprosarium, from two years to perhaps as little as three months. This does not mean a cure in three months, but that the patient would no longer be infective and would thus be able to mingle with his fellows in the outside world. This implies that with a little extra expense existing leprosaria could handle many more patients than at present. Since there are upwards of three million lepers in the world, including 750,000 in British-administered territories, a means of reducing the demands on leprosaria is to be praised.

"Atomic World"

ANOTHER step in the life of Europe's first atomic energy journal has been taken by renaming *Atomics*, the Leonard Hill journal started in 1949. The new title is *Atomic World*, a name that indicates the international nature of atomic energy development and the intention of the journal to mirror this development. The format of the journal has been changed and the typography and layout modernised. Among the contributors to the November issue are Sir John Cockcroft, who discusses three generations of civil power reactors; three authors from the U.K.A.E.A. industrial group who describe Britain's Advanced Gas-Cooled Reactor; and Dr. D. F. Shaw of the Clarendon Laboratory, Oxford, who writes on radiation exposure records. The editorial staff have contributed a survey of world plans for nuclear power and a review of heavy water production.

It is the intention of *Atomic World's* editor, Dr. M. C. Reece, to survey each month the atomic programmes of the leading countries in this field. Radiochemicals and nuclear instrumentation, as well as electricity generation, will be covered. The journal's twofold task will be to inform the world of British achievements and to tell British readers of progress overseas with particular emphasis on market potential, for, of course, the future of Britain's atomic industry is inseparable from progress abroad.

Revealing these plans at a reception to launch *Atomic World* held at Leonard Hill House, London, the chairman of the publishers, Mr. W. Leonard Hill, pointed out that the journal is one of a group of specialised periodicals which between them cover the technologies and industries which gave birth to nuclear energy. Chemistry and chemical engineering are covered by MANUFACTURING CHEMIST and *Chemical and Process Engineering*, instrumentation, electronics and control systems by *Automation Progress*, heavy contracting and civil engineering by *Public Works* and metallurgy by *Corrosion Technology*. As Mr. Hill remarked, the journals are interdependent and mutually supporting. The experience and contacts gained by one, aid the development of another. His audience was thoroughly interested in this brief glimpse of publishing technique and expressed their good wishes for the future of *Atomic World*.

No more nationalisation

IN THE present political climate it is easy enough to laugh away the idea of further nationalisation of industry.

The Labour Party have shifted their ground so much over the years that it is excusable to think that most members do not now believe in nationalisation themselves. But it would be very wrong to think that British Socialism is no longer convinced that Whitehall should run the basic industries—including chemicals. Outright nationalisation may be proposed now only for steel and long distance road haulage, but in the latest Labour policy pamphlet *Plan for Progress* a National Investment Board is proposed. This would supervise the investment policies of "a few hundred large firms," giving the gentlemen from Whitehall places on hundreds of important boardroom tables free and for nothing. Given a choice between a bullet and strangulation most people would choose the bullet, *i.e.* outright nationalisation.

It is clear that the price of freedom from nationalisation is constant vigilance. He who laughs it off now may well be laughing differently a few years hence.

It is well to remember that once an industry has been scrambled into a nationalised omelette it is impossible to get the eggs back into their shells again. Even the Federation of British Industries feels that some nationalised industries can never be returned to private hands again. But they are determined that there should be no more nationalisation and say why vigorously, lucidly and convincingly in a 68-page booklet issued last month (5s.).

Two extracts from the booklet are memorable.

> "The purpose of industry and commerce is to provide the goods and services which make our standard of living. To produce these goods and services the resources available—raw materials, capital equipment, effort and skill—are limited. The problem is to use them as efficiently as possible to produce the things people want."

Naturally the F.B.I. thinks that free enterprise is the best solution of this problem . . .

> "Free enterprise is an efficient system because it gives men the incentive to seek progress through more efficient ways of doing things; at the same time it subjects them to the pressures of competition from others who seek the same end. In the result the consumer gets the things he chooses—not those that some authority thinks he ought to have—and he gets them in ever-increasing quantities."

With the experience of over a decade of nationalisation, who but the most doctrinaire could argue that a state-controlled industry can do this better than a private one?

The case against further nationalisation seems overwhelming, but this does not mean that the major nationalised industries—coal, gas, electricity and the railways—should not be given every encouragement to increase their efficiency and their profits. It is not always appreciated that the State industries employ nearly two million people and have an annual turnover of £2,610 million. This illustrates the importance to the economy of their profitable operation.

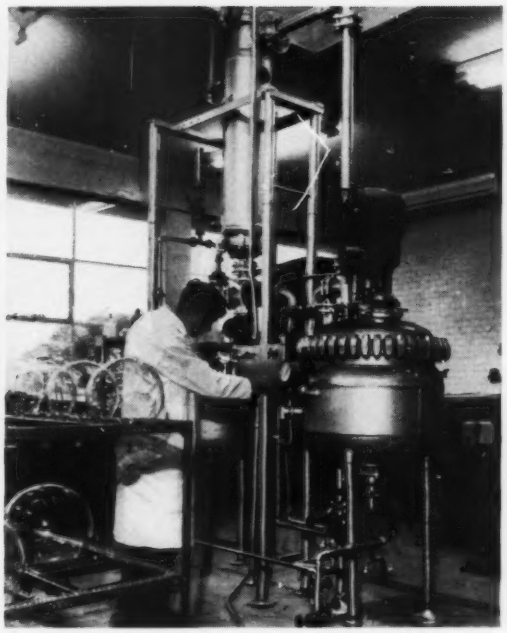
Reps are welcome

IT IS a sound principle of science that an ounce of observation is worth a hundredweight of speculation. So we were glad to see that a pharmaceutical company has quietly applied this principle to the controversy about medical propaganda. Many doctors, apparently by extrapolating their own reactions, have drawn a picture of the medical profession appalled by the flood of medical advertising that pours into their surgeries and cowering before the army of medical representatives that call upon them. Do these critics in fact speak for the profession? According to Vitamins Ltd., they do not.

This company compiled six questions and asked their representatives to get answers to them during the course of their routine calls on doctors. No persuasion was to be used. If the doctor did not want to answer, that was the end of the matter. In fact, out if 3,535 doctors questioned (10% of the total number in the N.H.S.) only 126—less than 3·5%—refused to co-operate.

The replies showed that 86% "almost always" saw medical representatives, and 86% wanted to see them either three times or twice a year. A question about reading pharmaceutical advertisements was answered as follows: 21% said "almost always," 43% said "often," 26% said "seldom" and 10% "hardly ever." But only 27% said they preferred getting information from advertisements in journals; 81% preferred discussion with representatives and 13% preferred getting it through the post.

This survey provides an effective rebuttal of the criticism of representatives, but only a partial rebuttal of the criticism of advertisements. One criticism of the survey itself is that it does not take account of the doctors who refused to see the representatives anyway. Against this is the overwhelming approval of representatives by those doctors who did grant interviews. Whether this is a tribute to the representatives employed by Messrs. Vitamins or to representatives generally is a point that could only be resolved by other firms making their own surveys. But since this is bound to raise more protests in the medical press perhaps it is well to let the present survey cast its mantle of approval over representatives as a species. Congratulations to Messrs. Vitamins on their enterprise. (The full survey is published in the *British Medical Journal*, November 1, 1958, pp. 1096-7.)



Left: Laboratory tablet coating pan in pharmaceutical development section contrasts with the full-scale compression coating machine on which tests are being made. Right: Pilot plant for synthesising new compounds in the organic chemistry section.

Wyeth's New Research Laboratories

A small but well-equipped research team is now working in the new laboratories established by John Wyeth and Brother Ltd., at their new factory at Havant, near Portsmouth. We recently visited the laboratories and saw work in progress on analgesics, antibiotics, anæsthetics and central nervous system stimulants.

ON THE south coast, between Portsmouth and Folkestone, a number of pharmaceutical enterprises, almost all American-affiliated, have been established since the war. The latest is that of John Wyeth and Brother Ltd., in New Lane, Havant, near Portsmouth. Although the factory is new Wyeth are no newcomers to Britain. They have been manufacturing in this country since 1925 and the organisation is managed and staffed entirely by British nationals. Chairman of the company is Mr. J. C. Gormley, who is also chairman of the International Chemical Co. Ltd., and the managing director is Mr. Peter Keddie.

The Wyeth organisation was founded in 1860 in Philadelphia and was developed into a small, family type firm of manufacturing chemists with a few specialities. It was bequeathed to Harvard University and then sold to an expanding organisation with interests in the pharmaceutical industry. This, very briefly, is the background of the organisation which was established in this country 33 years ago.

When Wyeth moved to Havant the opportunity was taken to provide research as well as manufacturing facilities. The factory now produces the bulk of the Wyeth range of 40-odd products. These include such well established preparations as Algipan balm, Aludrox (aluminium hydroxide antacid) and Petrolagar (mineral oil emulsion laxative), and modern drugs such as Penidural (benzathine penicillin), Equanil (meprobamate) muscle relaxant, Evramycin (oleandomycin), Isolevin (*l*-isoprenaline), Mephine (mephentermine), Neo-Endrine and Streptets (broad-spectrum antibiotic formulations), S.M.A. infant food, a number of vitamin products, muscle relaxants, analgesics, barbiturates, anti-spasmodics, etc.

The research laboratories have been operating for about one year and although they already represent an investment of £250,000 are not yet fully equipped. Nor are they yet fully staffed. The present staff of 32 provides the basis of future development. It is hoped that the number will double but expansion will be in accordance with the policy of carefully choosing the right people for the particular job in hand.

Research and development are controlled by Dr. Fryers, the technical director. There are four main sections—*organic chemistry*, where new compounds are synthesised; *pharmacological*, where they are tested; *clinical investigation*, where the more promising are further evaluated; and *pharmaceutical development*, where pre-manufacturing problems are ironed out. In addition there are those essential ancillaries, the *bacteriological* and *microbiological* sections.

Illustrative of the high cost of even modest research facilities is

The new Wyeth building in New Lane, Havant. The research laboratories are housed here.

the elaborately and expensively equipped workshop where highly specialised equipment and gadgets for the laboratories are turned out.

On a recent visit to the new laboratories we were told by Mr. Keddie that the facilities are part of an international research organisation but nevertheless work independently on their own ideas. Information is exchanged between Havant and Wyeth research centres in the U.S. and Canada, and in co-operation with friendly companies in France, Italy and Belgium.

Subjects of current interest at Havant are analgesics, antibiotics, anæsthetics and central nervous system stimulants. A product now passing through the pharmaceutical development stage is ethoheptazine, a promising analgesic which may be a replacement for codeine. This is one of a number of analgesic preparations currently being investigated. Particular attention is being paid to compounds containing the thiazole nucleus.

Equipment in the organic chemistry laboratories ranges from microscale apparatus to 25-gal. vessels for manufacture up to kilogram quantities. There are two large vessels, one 20 and the other 25 gallons, both glass-lined and equipped for heating, cooling, agitating and distillation. Ten and 20-litre glass flasks are also used. Other equipment includes two high-pressure hydrogenators, one of the shaking type (Charles W. Cook and Sons Ltd.) and the other non-shaking (Baskerville and Lindsay Ltd.).

The most important and expensive analytical instruments are a Perkin-Elmer " 21 " infra-red spectrophotometer and a Perkin-Elmer " 4000 " ultra-violet spectrophotometer. A card index of infra-red spectrograms is being built up to aid rapid identification of compounds and it is also intended to subscribe to an international service of infra-red spectrograms. Although expensive, this equipment gives rapid and accurate determinations of the structure and purity of the hundreds of compounds synthesised for testing. This work is inevitably tedious and laborious—only one compound in a hundred might show suitable pharmacological activity—and it is essential to have the most rapid and reliable means of identifying compounds.

Pharmacology

A range of biological testing methods is used in the pharmacology department. Guinea pigs, rabbits, rats, mice and other small animals are kept under controlled conditions.

Ultra-violet spectrophotometer for analysing new compounds. An infra-red spectrophotometer is also installed.

Elaborate facilities are provided for cleaning and sterilising cages and the animals are kept in a room at a constant temperature and at a relative humidity of 50 to 60.

An interesting test demonstrated during our visit was the evaluation of one of a series of tranquillisers based on the biochemistry of the nervous system. Small animals—*Meriones Libicus*—are injected with the drug and exposed to grass snakes. Normally these animals have a dramatic and fierce attack response when confronted by a snake, but under the influence of the drug they are quiet and docile.

In another room isolated intestines of guinea pigs were being used to evaluate antihistamines, ganglionic blocking agents and atropine-like drugs. Histamine, nicotine and acetyl choline respectively are used as reference drugs, *e.g.* gut treated with nicotine which responds to a compound identifies it as a ganglionic blocking agent. The response is traced by a scribe on a smoked drum which may be varnished to give a permanent record of the test.

Electronic recording techniques are used for tests on animals. For example, electrodes placed on the skull of, say, a rabbit pick up the electrical impulses induced by a drug and provide electroencephalograms. Electrodes placed on the chest give electrocardiograms, and so on. These techniques are capable of considerable development in pharmacological research.

Pharmaceutical development

The pharmaceutical development department is equipped with a range of facilities for devising production methods suitable for the factory. The department is capable of making batches of products of up to 25 gal. for clinical trial. Illustrative of the work done is a programme for formulating tablets that can be satisfactorily coated on a compression-coating machine. To aid this work a full-size Manesty *Drycota* machine has been installed for testing various formulations.

The bacteriology department is equipped with the usual apparatus for drug testing. Part of their work comprises the control of the potency of batches of *Penidural* (benzathine penicillin) products made in the factory. However, production control is normally exercised in the separate control laboratories.

Exceeding Small

Recent Developments in Grinding and Grinding Machinery in the Pharmaceutical and Fine Chemicals Industry

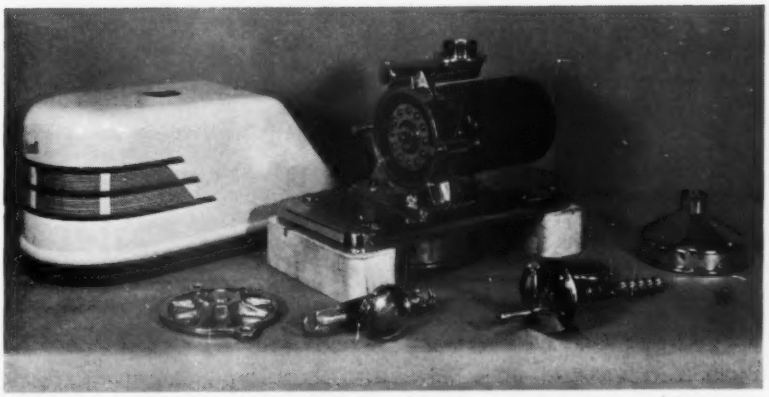
Specially Contributed

ALMOST all of the myriad chemical products made today pass through at least one stage when they are crushed, granulated, pulverised or ground. Almost as varied is the array of equipment and machinery available to do this. Little wonder, therefore, that size reduction is a unit operation which appears in the training syllabus of every chemical engineer.

For the manufacturer who wishes to learn the rudiments of size reduction, Perry's "Chemical Engineer's Handbook,"[1] revised in 1950, can be very helpful and an interesting, though less comprehensive monograph is "Industrial Grinding and Reduction Plant" by C. S. Darling.[2] Alternatively, he may turn to G. C. Brown's "Unit Operations,"[3] where the author states in a chapter devoted to size reduction that its purpose is "not only to make . . . 'little ones out of big ones' . . . when the effectiveness can be measured by the degree of fineness of the product, but also to produce a product of the desired size or size range. The size requirements for various products may vary widely and hence different machines and procedures are employed" which he proceeds to describe.

Despite the differences in size reduction problems and in the properties of the materials handled, there are only about eight distinctly different ways of making small pieces out of large pieces. Only four of these, namely, (1) slow compression, (2) impact, (3) attrition, (4) cutting or tearing, are used by commercial machines.

Grinding problems are sometimes broken down and differentiated in terms of the relative fineness of the product. Roughly, coarse grinding can be classified as from 6 to 35 mesh; intermediate from 35 to 70% passing 200 mesh; and fine grinding from 70% minus 200 mesh down to 10 microns and even smaller.[5] Sometimes in the chemical industry the problem is merely to convert awkward lumps of materials into a freely flowing powder which has "customer appeal." Other times, the chemical must be ground in order to make it more reactive; the difference between one manufacturer's products and another's is frequently the fineness or uniformity of the powder.



A high-speed pulveriser of the swing hammer type made by British Jeffrey-Diamond Ltd. The streamlined cover and ease of dismantling are of particular interest from the hygienic viewpoint.

No single pulverising plant can be applied to all duties successfully. Differences in size, hardness, toughness, impurity tolerance, chemical nature, moisture content and other factors, all call for modified designs. Taggart[6] summarised the steps in preparing a fine product as:

(*a*) coarse or primary crushing,
(*b*) intermediate or secondary crushing,
(*c*) fine grinding.

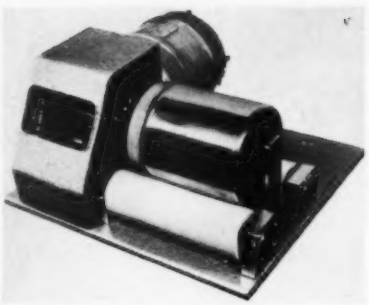
All comminution is essentially a stage process, utilising in successive steps machines designed for the particular material and for the degree of fineness to which it must be reduced. Jaw crushers, stamps, toothed rolls and gyratory crushers are typical primary crushers; swing hammer mills, ring mills, cone crushers are extensively used for secondary crushing, whilst smooth rolls, pan mills, ball mills and tube mills form the basis of fine grinding. Pharmaceuticals call mainly for the finer forms of grinding, but indirectly all types of size reduction play a part in the preparation of a saleable product.

Primary crushing

Sugar cane crushing mills have been known for 500 years and were indeed among the earliest machinery used in the food industry. Modern sugar crushing mills[7] consist of six strands of three rollers 37 in. diameter by 84 in. long. These achieve a juice extraction efficiency of 96% to 97%. The mill rollers are of cast iron grooved to increase the grip on the sugar cane. Each of the six mills is powered by a 600 h.p. steam turbine which drives the rolls at 3 to 4 r.p.m. Whilst the carbohydrate sugar has been extracted in this way for very many years, the commercial extraction of proteins direct from crops not normally used for foods is new.[8] A mill suitable for recovering the succulent parts of leaves consists of a double beater with one arm working at a different speed and in the opposite direction to the other. A 20 h.p. motor driving this machine is claimed to produce up to 6 tons/hr. of useful ground material.

As with other forms of primary crushers, jaw crushers are required to break minerals into smaller pieces of as regular a size as possible with the minimum splinter and dust formation. This can be aided by providing different oval paths for points on the eccentrically mounted jaw face[9] or by arranging for the

narrowest crushing gap to be in a plane containing the axes of rotation of the two eccentric shafts which move the jaws at a high striking speed in opposite directions.[10] Gauldie[11, 12] has contributed to our understanding of the operation of jaw crushers and gyratory crushers. A mathematical study was made of these primary crushers while working upon rocks and a relationship between the geometry of the jaws and the output was determined. Equations were developed based upon certain assumptions, namely, that the angle included between the jaws at "nip" level was low enough to ensure that the largest lumps fed to the hopper were caught and broken without recoil; that the outlet jaw surfaces were correctly contoured to discharge the crushed material; that the charge in the hopper did not exceed the practical maximum for the crusher and that free descent of the grist occurred immediately the moving jaw moved backwards. The gyratory crusher was likened to the jaw crusher in which a large number of elementary V-shaped jaws operate in succession. As far as output is concerned, "the moving crushing surface," he states, "may be regarded, therefore, as expanding and contracting, umbrella-fashion, in simple harmonic manner." Crushing with the gyratory occurs, therefore, during the "expansion" stroke and descent of the crushings takes place during the "contraction" stroke. For a 36 in. gyratory crusher with a 56° cone base angle, the optimum speed for maximum output in his experiments was 400 r.p.m. Gauldie calculated performance curves showing the increased output obtainable by opening the discharge settings, increasing the base angle and reducing the frictional characteristics of the material. The aim in operating a gyratory crusher should always be to avoid over-compacting of the material being crushed and, when this condition was just satisfied, the optimum output rate was obtained.



This miniature ball mill made by The Pascall Engineering Co. Ltd. consists of 2 in. dia. rolls which can accommodate containers up to 4 in. dia. with lengths up to 5½ in. A fractional h.p. motor and integral gear box give an output speed of 155 r.p.m. on the driven roll.

Secondary crushing

Probably the biggest single improvement in all forms of crushing and grinding machinery in the last decade is the almost complete changeover to individually motorised units. The advantages of increased flexibility in plant siting afforded by the direct drive electric motor are obvious to the chemical engineer, although perhaps less obvious is the improved efficiency of operation. The power absorbed by belting and pulley systems is

Table I.—How Typical Size Reducers Perform[4]

Type	*Action*	*Typical feed sizes*	*Typical product sizes*	*Capacity range tons/hr.*	*Power required Hp.-hr./ton*	*Used extensively for*	*Not usually used for*	*Remarks*
Jaw crushers ...	Compression	6-72 in.	1-11 in.	10-1,000	0·3-1	Medium and hard rock	Soft, sticky materials	—
Gyratories:								
Large	Compression	6-72 in.	1-11 in.	35-3,500	0·2-0·7	Medium and hard rock	Soft, sticky materials	—
Small	Compression and impact	1-10 in.	¼-1½ in.	10-600	0·5-3			—
Roll crushers:								
Smooth ...	Compression	¼-3 in.	⅛-⅜ in.	3-150	1-1½	Medium and tough, abrasive feeds	Large slippery lumps	Gives few fines; reduction ratio 4 : 1.
Toothed ...	Shear, attrition, impact	3-20 in.	2-8 in.	5-1,000	0·2-0·5	Friable feeds	Hard rock	Gives few fines; reduction ratio up to 8 : 1.
Revolving mills:								
Rod	Attrition (impact)	¼-1 in.	4-28 mesh	3-120	0·5-4	Pregrinding abrasive feeds	Fine grinding	—
Ball, pebble, tube, compartment ...	Attrition and impact	30 mesh to 1 in.	20 to −200 mesh	0·5-75	10-20	Fine-grinding abrasive feeds	Soft materials	Often used for mixing and blending.
Hammer mills:								
Impactors ...	Impact	10 mesh to 10 in.	48 mesh to ⅛ in.	0·2-600	0·5-10	Abrasive feeds	Fine grinding	Handles damp feeds.
Swing hammer mills ...	Impact and attrition	20 mesh to 40 in.	−325 mesh to 2 in.	0·05-400	1-200	Almost any non-abrasive material	Abrasive feeds	Coarse to ultrafine reduction.
Cutters and shredders ...	Cutting	1-12-in. wide sheets	4-100 mesh	0·1-10	10-25	Soft lumps; fibrous, rubber, plastic materials	Hard materials	—
Ring roll mills, bowl mills ...	Rolling compression	20 mesh to 1 in.	−325 to 20 mesh	0·02-20	5-200	Soft to fairly hard materials	Abrasive feeds	Large amount of fines produced; mill usually air swept.
Attrition mills	Attrition	⅜-1 in.	−200 to 20 mesh	0·2-5	15-200	Soft, fibrous materials	Hard, abrasive feeds	—
Fluid energy mills	Impact (attrition)	100 mesh to ½ in.	1-30 microns	0·1-10	*	Moderately hard, friable feeds	Soft, sticky materials	Ultrafine reduction.

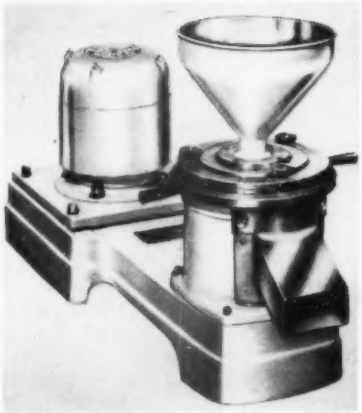
* 1-4 lb. of steam or 6-9 lb. compressed air per lb. of product.

very high and even machine cut gearing acounts for 12-15% of the total driving power.[13] The energy used in size reduction is large whether viewed from a unit operation or upon a national or world basis. For example, it has been stated[14] that the annual world production of cement during 1928 was 90 million tons. For this some 250 million tons of coal and clinker were milled, consuming 10,000 million kWh., an amount of electrical energy seven times the power consumption of Greater Berlin in 1929.

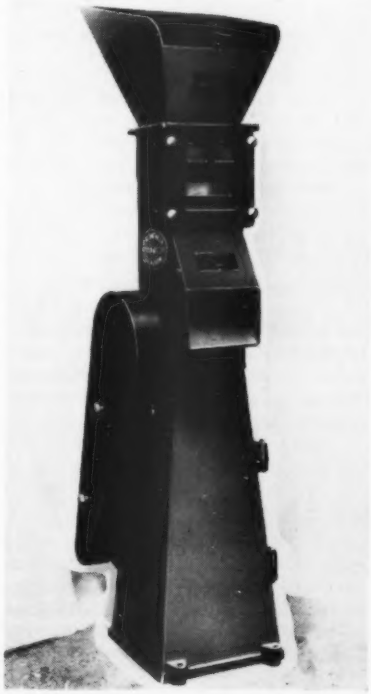
Another general improvement common to a variety of mills is the provision of a closed circuit system. For small particles, air or water is used to transport the grist through the crushing zone and to the sizing plant.[15] The dust-tight, air-swept mill is essential for pulverising silica powders[16] and dangerous chemicals where hygiene and health regulations must be respected. Air swept mills and crushing systems may be supplied with heated air to provide "free crushing" of moist materials. Similarly, inert gases are frequently employed to reduce decomposition of oxidisable products or to prevent fires and dust explosions. The United States Fire Protection Association, Dust Explosion Hazards Committee[17] has prepared 17 codes or standards which are applied in various industries. Almost any fine dust can form a potential explosive mixture under certain conditions, particularly when electrostatic charges build up on the surfaces of the ducting used in closed circuit grinding. The use of radioactive sources for dispelling static must not be overlooked.[18] The manufacture of nitro-chalk[19] presents an interesting example of closed circuit milling, the crushed carbonate being pneumatically transported to the ammonium nitrate treatment plant. The process of crushing was made largely automatic to interlock with the continuous operation of the plant.

Swing hammer mills

Swing hammer mills are traditionally applied universally for the disintegration of fibrous materials. A 14-page illustrated booklet[20] described British-made swing hammer shredders for the reduction of a large range of commodities, including angelica root, bark, ginger and liquorice. These machines have been applied in multi-stage processes. The hammer mill is particularly adapted for use with screens which can be rapidly changed without interruption of mill operation.[21, 22] This facility can be particularly useful when a range of finished sizes is required from the same basic chemical. A new form of mill for use in the fine chemicals industry is completely built of stainless steel and has rotor arms terminating in either a knife edge or a hammer face.[23] The change from one to the other is made by reversing the direction of rotation of the rotor. A generous screening area is provided and interchange of screens is accomplished in a matter of seconds. The speed of the mill is variable over a ratio of 5 : 1. Another mill suitable for the comminuting of fine chemicals[24] has a swing hammer working against a series of interchangeable screens which grade the material down to 200 mesh. Provision is made for watercooling so that the mill is suitable for use with pharmaceuticals, including antibiotics. *Atomill* grinders,[25] produced by a British firm, are now supplied in a range of sizes from small laboratory units operating at ¼ h.p. to production machines absorbing 15 h.p.



The stainless steel rotor of this multipurpose colloid mill operates at speeds up to 12,000 r.p.m. The mill is said to be particularly suitable for the preparation of antibiotic dispersions and similar products. Manufacturers are Premier Colloid Mills Ltd.



An output of 1-2 cwt./hr. is claimed for this dry granulator available from J. G. Jackson and Crockatt Ltd. The machine breaks down the product in two stages, giving a minimum of unwanted fines.

Disc and peg mills

There is a growing tendency to disintegrate materials with pulverisers running at speeds as high as 4,500 r.p.m. The rotor is often a pinned or pegged disc revolving close to similar projections in the casing or on a member having a reverse direction of rotation. The grinding action is due to combined impact and attrition. An interesting feature of high-speed pulverisers is that they generate by centrifugal force their own air stream and are thus self swept. The *Kek* pulveriser[26] has been improved by a new air separation device and by the provision for sweeping the mill with an inert gas to minimise the fire and explosion hazard. Another disc mill is fitted with a hydraulic pressure regulator to adjust the spacing of the discs.[27] This mill is proposed for the grinding of pigments, ink or chocolate. High rotor speeds are essential for the impact grinding of resinous substances without gumming up.

Cronan[28] described a 27-in. pin-disc mill working at a peripheral speed of 28,000 ft./min. which is particularly suitable for pulverising P.V.C. and similar tough materials. The stainless steel or bronze pins when worn may be rotated a quarter turn so as to present a new surface to the impacting solids. Pin mills are particularly suitable for the grinding of free-flowing, crystalline solids, drugs, etc.

Ball mills

Probably the most versatile of fine grinders, the ball mill is used under a variety of conditions on hard and soft grists, in both dry and wet states. Coghill and De Vaney[29] carried out experiments into the working of ball mills and they concluded that wet grinding gave 39% more capacity and 26% greater efficiency than dry milling. The efficiency of battered balls was 11% less than that of new spherical balls. These experimental results relate to one set of conditions only and they cannot be regarded as valid for all classes of ball milling, especially when treating soft materials. Ball mills are universally used in the chemical industry for grinding to various degrees of fineness such widely differing products as manganese oxides, barytes, gypsum, wood and cereal flour, etc.[30]

For the very fine grinding of talc, pigments, creams, etc., the vibratory ball mill appears to be gaining favour. Two such air-swept mills have a baffle plate separating the inlet charge from the crushings leaving the mill and are vibrated by out-of-balance weights mounted axially,[31,32] The unbalancing weight may be concentrated at the inlet end only to obtain a greater vibratory effect at the end [33] and similar effects may be obtained by providing an epicyclic motion.[34]

Roller mills

The roller mill is pre-eminent for the fine grinding and homogenising of pastes, cosmetics, ointments, etc. The mechanism for roll adjustment is of necessity very important and often complicated and is a constant spur to invention. The hydraulic control of roll pressure and alignment is a growing trend which has been described in numerous patent specifications.[35] Majumdar[36] has described the preparation of Indian graphite. It is converted almost to a colloidal state by repeated grinding in a roller mill.

Fine grinding

Colloid mills. There are several forms of mill which are currently in use for the ultra-fine grinding of chemicals and pharmaceuticals. Kingston[37] has described in an authoritative manner the *Micronizer* fluid energy jet mill which finds application where the product must have a particle size of 5 microns or less. In this type of mill the charge of solids is swept through a chamber in suspension in a carrying fluid where it meets a high-speed jet of compressed air or steam. Comminution of the particles occurs by collisions between them. The grinding energy is supplied by air compressed to 100 p.s.i. or steam at 100-200 p.s.i. The mill may be operated over a range of temperatures from below O°C. (if air is used) to 650° or 750°C., thus affording a means of breaking up the particles at a temperature best suited to the material. Capacities range from ½ to 4 lb./hr. for the 2 in. mill to 500 or 3,000 lb./hr. for the 30 in. mill. Micronizer installations are used for a large variety of chemicals and pharmaceuticals and where explosive powders are encountered, the mills are fitted with fire suppression devices. The popularity of fluid energy mills for fine grinding appears to be increasing.

Leclercq[38] considers that all particles less than 10 microns are liable to electrostatic firing and possible explosion when in motion in a gas which can support combustion. Accurate data are presented, derived from carefully standardised experiments on sulphur, sugar, polymethyl methacrylate, tetryl and cordite.

A finer dispersion greatly improves the efficacy of pharmaceutical and cosmetic emulsions and the taste and tolerance of luxury foods is enhanced; therefore, in many chemical applications, the term "grinding" is often used to describe an operation which could more properly be considered "dispersion." The registered name *Dispersator*[39] is an apt combination of "dispersion" and "disintegrator" and refers to a machine for producing so-called colloidal mixtures and homogenised products. Most conventional types of homogeniser employ methods of hydraulic shear to bring the dispersed phase into a state of fine subdivision in the order of 1 micron. One colloid mill based upon a form of pin mill has been described[40] and Jordan and Burbine[41] claim an unusual method of aiding the fine grinding of calcium salts by the addition of 0·05% of a mixture of oxalic acid or ammonium oxalate to the charge.

The Steel-Shaw laboratory mills have been well received and the large mill (10 gals. capacity model) is now welcomed.[42] This machine will mill materials wet or dry and it finds a wide range of uses in the experimental manufacture of paint, ink, dyestuffs and cosmetics.

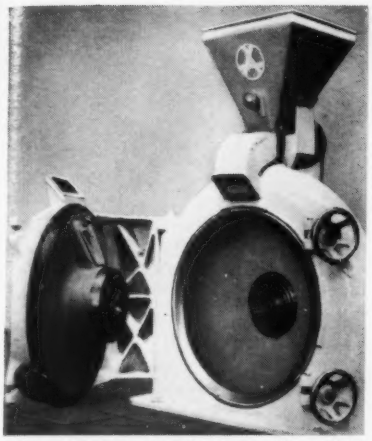
The dust resulting from very fine grinding of chemicals is often a serious menace to the health of workers and for this reason extraction fans and ducting have been fitted at all danger points. However, the most logical and economical remedy is to confine the dust at source. Very useful for handling powdered materials such as fullers earth, soda ash, powdered aspirin, starches, etc., over distances of 50 to 1,000 ft. is the Fuller-Kinyon pump[43] equipment.

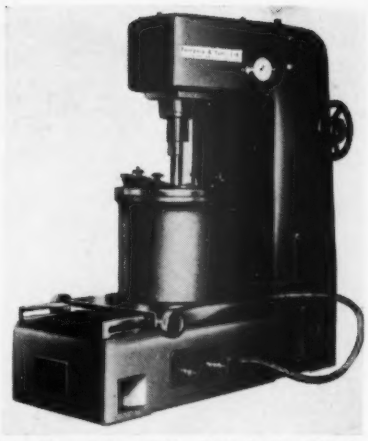
Laboratory and experimental mills. The transition from the research bench to the development laboratory and to the factory is a problem which can be minimised by having equipment which reduces chemical products to the same particle size and shape whether in ton lots or on the gramme scale. A most useful tool for this purpose is the *Angle Disintegrator*.[44] It is claimed to be suitable for crushing, grinding, pulverising, pulping, shredding, triturating and defibrising, and at the same time it can be adapted equally well for homogenising, blending, dispensing, beating, dissolving or mixing. A perforated stainless steel screen completely surrounds the swept area of a steel rotor and the feed, introduced above the centre of the rotor, is thrown outwards towards the screen.

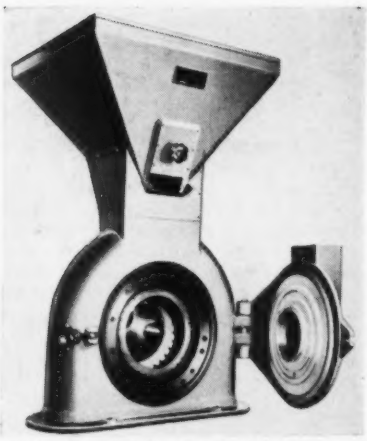
Sturtevant Engineering Co.[45] have a new range of laboratory sample preparation crushers including a small hammer mill designed to handle moderately hard materials such as barytes, bauxite and gypsum as well as a whole range of softer chemicals.

Laboratory-sized jaw crushers have been described in trade literature.[46] The Casella[47] grain mill is a laboratory-sized apparatus designed specifically to crush cereals efficiently and rapidly for test purposes. It has wider uses. Another useful laboratory mill will probably develop from the vibratory crusher idea[48] in which several crushing drums are connected together resiliently in a framework of springs. In the ultra-fine grinding field, the *Polytron*[49] is a new, powerful ultrasonic generator, giving frequencies up to 240,000 cycles/second, at power ratings up to 1½ kW. which may be adapted for the purpose of producing colloids.

(*Continued on page* 512)







Left: A feature of this turbomill available from Bramigk and Co. Ltd. is the 100% access to the mill chamber for cleaning and maintenance. Centre: Dispersions may be inspected continuously in this Torrance " Attritor " grinder. Right: Free flow of the product is ensured by the wide chamber construction of the Alpine " Contraplex " grinder.

Size Reduction Machinery

Attrition grinding

DRYING and grinding are carried out simultaneously in the *Attritor* dryer-pulveriser, an air-swept unit mill which works on the attrition principle. The manufacturers are **Alfred Herbert Ltd.**

Hot air for drying is provided by a small coke or oil-fired stove adjacent to the mill. Drying can be controlled so that the materials can be completely dried or left with a residue of moisture.

Grinding can also be controlled to produce either a superfine or a coarse granulated product, with various intermediate gradings, as required.

It is claimed that wet sticky materials including sludges, filter cakes, and semi-liquids can be handled satisfactorily. Some preparation of the material before processing may be necessary when dealing with high moisture contents. Materials containing up to 80% moisture can be handled and drying efficiencies of 75 to 80% are regularly achieved, say the manufacturers.

Two or more materials can be intimately mixed during the drying and grinding process providing the materials are rough mixed or blended prior to feeding into the mill.

Due to the modest speeds of the machine, its general design and special material used for the grinding parts, maintenance costs are low.

An external fan type *Attritor* is a development of the standard internal fan design, its purpose being to provide very coarse gradings. This is achieved by slowing down the machine speed and fitting an external fan, enabling a greater volume of air for efficient grinding to be passed through the machine irrespective of rotor speed, and having the advantage of allowing the air volume to be varied within limits to suit individual grinding requirements.

The external fan machine can also produce superfine gradings if required, the change from coarse to fine involving merely an increase in speed and a slight alteration to the internals of the machine by fitting the requisite number of rejector arms.

Five of the seven machines in the *Attritor* range are available in either the internal or external fan form, the remaining two being available with an internal fan only.

Another attrition type grinder is the Bauermeister machine available from **Bramigk and Co. Ltd.** The main mill casting is designed for easy cleaning. The high-speed turbo element shaft is mounted on a deep groove ball and roller bearing housing assembly which can be removed as a completely separate unit from the main casing. The large hinged mill door gives 100% access to the mill chamber interior for ready removal of the multi-jawed sieve-ring and cleaning.

The designers have not overlooked the impact and pin-disc grinding principles which are well suited to certain materials. Transformation elements have been fitted to enable grinding to be done either way as well as by the turbo-attrition method. Materials can be pre-ground with the impact hammer elements, this partly kibbled and pulverised material then being fed back to the mill when it has been changed over to the turbo-elements for fine grinding.

The basic milling equipment has grinding chambers ranging from 6 in. to 32 in. and employs electric star delta motors from 2 h.p. to 48 h.p.

Various types of feed and discharge devices can be designed for use with the equipment.

The latest addition to the **Torrance** range of grinding and dispersing plant is the *Attritor* which, it is claimed, will give dispersions having a particle size of one micron or less.

The machine has a stationary grinding tank filled with small grinding elements having a size of $\frac{3}{8}$ in. and less, intermixed with the dispersion to be ground; an agitator keeps the whole charge moving and the result is a rapid fine grinding.

A cooling jacket surrounds the stationary grinding tank, providing good temperature control. The dispersions can be inspected continuously, additions can be made and corrections effected at any time. The tank can be heated if required.

A full range of sizes is available from the pilot batch 1S unit (capacity $\frac{1}{2}$ pint) up to the larger production units.

Vibration milling

The **Podmore-Boulton** *Vibro Energy* mill works on the principle of applying small forces at high frequency in conjunction with a special grinding media. The working volume is said to be at least 95% of the grinding chamber and the space available for grinding is the volume of the interstices between the media. The media normally used in the mill is *Alorite*, an abrasion-resistant alumina body, cylindrical in shape, chemically inert and resistant to attack by acids and alkalies. Due to its hardness the rate of wear is less and its high density enables wet grinding to be carried out at a much higher slip viscosity, using less water and reducing the drying-out time of the product. The use of *Alorite* ensures non-metallic contamination but the mill will work equally well with steel balls if the material is not

susceptible to metal contamination.

Advantages claimed for the machine are efficient and fine grinding with easy and accurate control of particle size coupled with freedom from contamination.

The entire weight of the chamber and its contents is supported on high tensile steel springs, thus eliminating the need for heavy bearings. The starting torque is low, consequently a direct on starter can be used and clutch and gearing become unnecessary. Heat generated during grinding can be dissipated through the top of the container. A valve is fitted at the bottom of the vessel for running off the ground product. The mill can be run whilst discharging, thus facilitating the handling of thixotropic materials. It is also practicable to draw off test samples without stopping the machine.

A range of six machines, each in two sizes, is available for both wet and dry grinding. Mills can be arranged for batch or continuous grinding in open or close circuit. A before-and-after sales service is available covering both technical and mechanical aspects of the *Vibro Energy* mill.

Pin disc mills

Kek Limited have recently re-designed the whole range of their high speed, pin disc type pulverisers which are used for the dry size reduction of a wide variety of fine chemicals and pharmaceuticals. The largest size, the No. 1 Kek mill (30 h.p.-50 h.p.), and the *Minikek* mill (1 h.p.) which is intended primarily for laboratory or pilot plant duties, are already available and the No. 3B (10 h.p.-15 h.p.) and No. 4B (5 h.p.) mills will be available from January 1, 1959. Hitherto, all Kek mills have been driven through a gear box, but in the new series only the No. 1 size incorporates a gear box and this is of a modified type. The principal feature of the No. 3B and No. 4B mills is a new type of belt drive which has enabled maintenance to be simplified and ensures only a modest temperature rise in operation. Furthermore, it is claimed that, due to the economies in power consumed, these mills show a 20% increase in output/horse-power when compared with their predecessors. All the mills referred to above are suitable for the production of powders within the size range 50 B.S.S.-300 B.S.S., at rates of throughput from 50-5,000 lb./hour.

For the size reduction of materials which show a tendency to impact and fuse on to the grinding parts of conventional pulverisers, e.g. DDT, aldrin, lactose, sorbitol and vanillin, Kek Ltd. have developed a pin disc mill containing a built-in air separation unit. This grinder, which is known as the *Superkek*, is also used for the production of powders of smaller particle size (5-20 microns, average) than are obtainable using a standard type pulveriser.

The feed hopper of this comminuting mill made by the Apex Construction Co. has been designed so that material can be fed from an elevator for continuous production.

Disc grinder

Alpine A.-G. of Germany have built a new type of grinding machine known as the *Contraplex* Wide-Chamber grinder. It is stated that this machine, available from **Lavino (London) Ltd.**, can be used for the grinding of nearly all soft to medium-hard materials to a high degree of fineness.

Grinding is achieved during the free flow of the material between intermeshing studs fixed to two discs revolving at high speeds; through the rotation of both discs extremely high velocities are achieved and the material being fed in to the mill is broken up into fine particles by impact at relative speeds up to 690 ft. per sec. By varying the speed, as well as the direction of rotation of each disc, the grinding process can be adjusted to suit the characteristics of the different materials to be ground.

When using sieveless grinding machines it is not always possible to obtain the desired fineness in the end product with just one pass through the grinding mill, and for this purpose an air separator, the *Mikroplex* spiral air classifier, which separates a fine mixture into two sharply divided fractions above and below a determined particle size is available. It is claimed that separations down to 2·5 micron can be obtained.

Colloid mill

Moritz Chemical Engineering Co. Ltd. have designed a horizontal type finishing mill, as an addition to their standard vertical type colloid mills, in which the shearing action has been particularly developed in order to increase its efficiency. The horizontal shaft is fitted with a male conical grooved milling element revolving at high speed within a corresponding female stator. The mill is provided with a micro-metric adjusting device with graduated scales to regulate distance between rotor and stator, so that the degree of fineness of the finished products may be controlled and compensation made for any wear after the mill has been in operation for a considerable time.

The mill illustrated is for use in a laboratory, but an extensive range is available for industrial use and high outputs.

Comminuting mill

The new No. 170 comminuting mill developed by **Apex Construction Ltd.** is intended for size reduction, in which coarse down to ultra-fine powders in the 1-25 micron range can be obtained; wet or dry granulation, and intense mixing of both wet and dry powders. This machine is a large-scale model of the No. 114 comminuting mill and has had several improved features incorporated in the design. The chamber sideframes have been constructed with vertical ends which permits sticky materials to be processed through the chamber without build-up. Furthermore, the bearings have been designed with labyrinth type grease seals. Each bearing is fitted with a grease valve by which excess or utilised grease is discharged into a grease cup which can be simply removed.

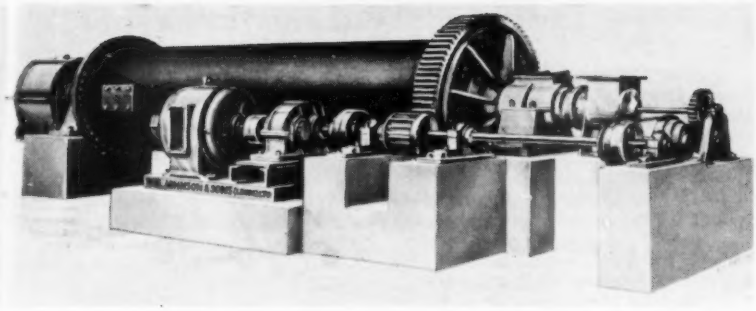
The mill can be direct driven by a 15 h.p. motor and fitted with a motor driven 6 in. screw feed. Speeds of up to 6,000 r.p.m. are standard. The feed hopper has been designed so that material can be fed from an elevator for continuous production. The machine is constructed in polished stainless steel and outputs of up to 6,000 lb. per hour are claimed.

"Tornado" mill

F. J. Stokes Corporation, Philadelphia, has acquired the *Tornado* mill, a granulating and mixing machine featuring 360° of screening area. The machine is available in three sizes.

Material is ground and mixed by a cluster of whirling blades attached to a common vertical shaft. These create an air flow and throw the material outward at high velocity against a cylindrical mesh screen which completely surrounds the rotor. In the process, the manufacturers claim, the material is reduced in particle-size uniformly, without excessive fines, and is thoroughly blended or mixed.

The number of blades and their spacing can be varied to give the best results on a particular material. From two to 14 blades can be fitted to the rotor-shaft, while the size of the mesh in the screen can be varied according to the particle-size desired. All parts of the mill that come in contact with



FIVE TYPES OF GRINDING MACHINE

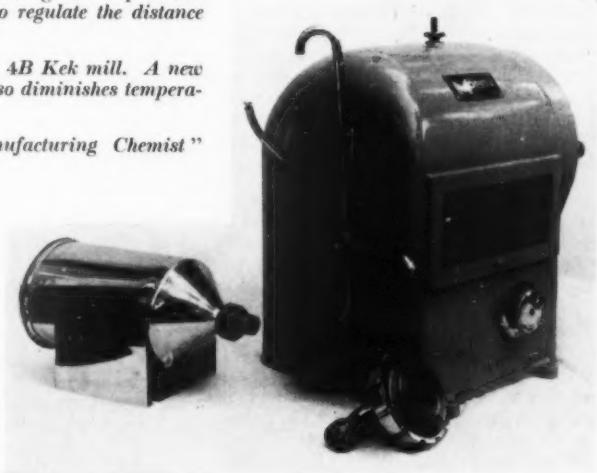
Top left: This compound ball and tubemill manufactured by W. Johnson and Sons (Leeds) Ltd. is said to give a product leaving only 2% residue on passing a 200-mesh screen, without the need for air separation on the dry process.

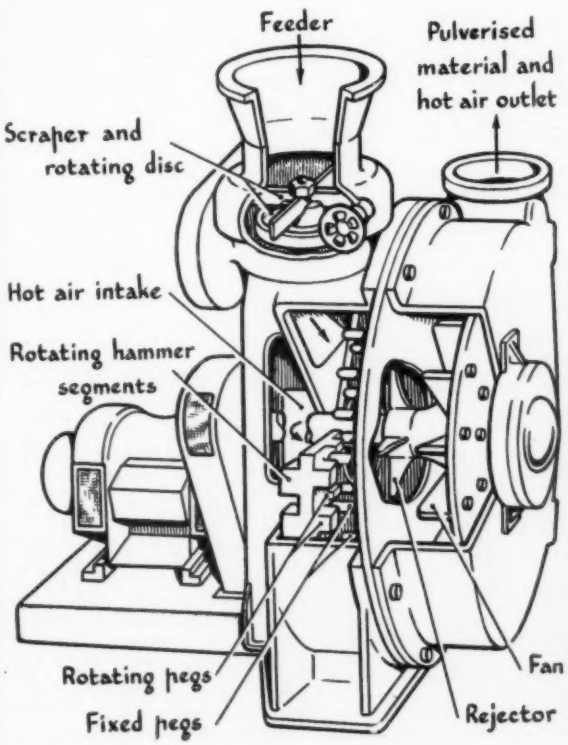
Top right: A rotor diameter of 10 in. and a screen area of 160 sq. in. are features of this Stokes "Tornado" mill. The size of the mesh in the screen can be varied according to the particle size desired.

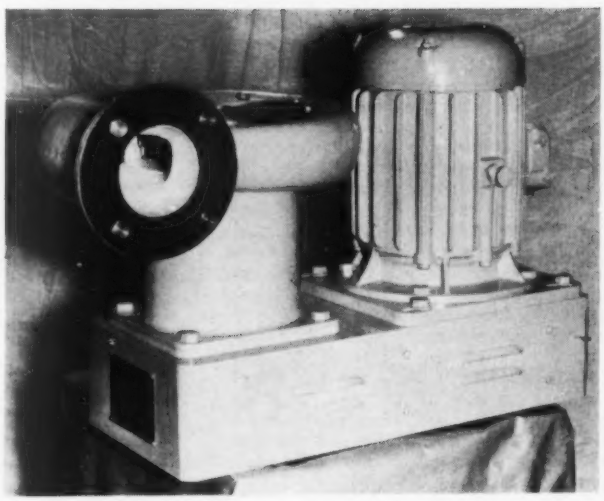
Centre right: Made by the Moritz Engineering Co. this finishing mill is provided with a micro-metric adjusting device with graduated scales to regulate the distance between rotor and stator.

Bottom right: An involute delivery ring is fitted to the No. 4B Kek mill. A new type of belt drive enables maintenance to be simplified and also diminishes temperature rise during operation.

Bottom left: The "Atritor" dryer-pulveriser. "Manufacturing Chemist" drawing.







material being processed are fabricated from stainless steel.

The mill is a compact unit, with drive motor and grinding head balanced on a cross beam supported on a vertical column. Grinding speed can be varied at will by selecting from three reduction ratios offered by the three step pulleys on the motor and grinder. The belts are totally enclosed for safety and cleanliness. The standard units now available are all mounted on castors.

Compound ball tubemill

William Johnson and Sons (Leeds) Ltd. manufacture a compound ball tubemill which, they claim, will deliver a product up to 2% residue on 200 mesh without the necessity of any air separation on the dry process, or classifier on the wet process. If a finer grade is required then air separation or classifier are required respectively.

The grinding chamber consists of a tube running at a slow speed, lined with renewable hard metal liners and provided with loose free moving grinding media. It is stated that if metal is inadvertently fed into the machine it does no harm but merely acts as an extra grinding medium. Where metallic contamination is to be avoided the interior of the tube is lined with stone and flint pebbles are used as the grinding medium.

The machine can be supplied coupled direct to a motor through a reduction gear or with pulleys for belt drive direct from a motor, to suit existing facilities.

Machines giving outputs from 1 cwt. up to 20 tons per hr. are available.

Pulverising mill

The *Micro-Atomizer* manufactured by the **Metals Disintegrating Co. Inc.**, of New Jersey, is said to eliminate the need for an air separator, bucket elevator and screw conveyor, combining these three functions in one operation.

Raw material is conveyed from the hopper to the feed tube through which it drops into the grinding chamber. After impact by the hammers it is picked up in the air stream and carried to the vanes of the separator wheels where the fine material is drawn through the wheels towards the centre by an induced air stream from fans outside the separator wheels. Coarser particles attain a higher centrifugal force, thus overcoming the air drag of the air stream acting on the finer particles, and this centrifugal force causes the larger particles to be rejected back into the path of the hammers for further grinding.

The particle size of the finished product is governed by three factors: (1) axial length of separator wheel vanes, (2) size of fan, (3) r.p.m. of motor. Hence, three sizes of separator wheels, three sizes of fans, and sheaves for three rotor speeds can be supplied as needed.

Industry's Publications

Organic Chemical Reagents. Monograph No. 36 (1958), published by Hopkin and Williams Ltd., describes the use of *p*-bromomandelic acid as a reagent for zirconium. A bibliography is included in the monograph.

Sugar Phosphates and Related Substances. The preparation, properties, and uses of the more important sugar phosphates are described in a 20-page booklet obtainable from the British Drug Houses Ltd. Many of the intermediates in the assimilation and utilisation of carbohydrates in plants, animals and micro-organisms are sugar phosphates.

Acid resisting silicon iron pipes and pipe fittings (B.S. 1333: 1958). This revised publication (22 pp. illustrated) deals with three types of pipes and pipe fittings: cone ended, spigot and socket, and plain ended. The size range is 1-12 in. nominal bore.

The main differences between this and the first (1946) edition are that there are now requirements for loose coupling flanges and also requirements for the 2½ in. (64 mm.) and 5 in. (127 mm.) sizes have been omitted.

New pharmaceuticals. Three publications from Ciba Laboratories Ltd. describe respectively, *Aturbane*, an orally effective anticholinergic effective in the treatment of Parkinsonism; *Ultranden*, an androgenic and anabolic derivative of testosterone, also effective orally; and *Tessalon*, a cough depressant which acts by reducing the sensitivity of the pulmonary stretch receptors.

Data on Piperidine. Two data sheets on 3-methyl and 4-methyl piperidine giving physical and chemical properties of the products are available from Robinson Brothers Ltd. They should be of interest in chemical synthesis where the properties of the piperidine molecule are desired to be modified.

EDTA in Analysis A bibliography of the analytical uses of *EDTA* has been issued by the Geigy Co. Ltd. The entries are grouped according to the type of use and cover literature published up to the beginning of 1958 in most countries of the world. *EDTA* and its derivatives are sold by the Geigy Co. Ltd. under the trade name *Sequestrol*.

EXCEEDING SMALL

(*Continued from page* 508)

Finally, it is worth noting, an interesting range of laboratory size reduction machines were exhibited at the Salon de la Chemie in Paris last year.[50]

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Veterinary Antibiotic Preparations

By G. N. Henderson, B.SC., M.R.C.V.S., and C. F. Abbott, B.PHARM.

As veterinary science provides more remedies for more animal diseases, the market for veterinary drugs will increase enormously. This market is already engaging the attention of many manufacturing chemists and many more will increasingly feel that they cannot afford to ignore this potentially rich market. The importance of antibiotics in veterinary medicine is shown by the estimate that over one-third of the annual drug bill is spent on these products. In this article the authors discuss current trends in formulation and list some of the important antibiotic products already being used for animal diseases.

MANY antibiotic preparations are presented in the same form for both human and veterinary uses. Indeed, there are many examples where the same product is used by both the medical and veterinary practitioner, although the manufacturer may differentiate between the two by preparing a special veterinary pack complete with suitable labels and literature. Other preparations are characteristic of veterinary practice only, and have no equivalent formulation in human therapy.

The similarities and differences will be apparent if we consider the different types of antibiotic preparations which are used in the treatment of animal diseases.

As mention has already been made in previous articles in this series of the use of antibiotics in pessaries[1] and intramammary injections,[2] further discussion is not necessary except perhaps to reaffirm their widespread use in these two forms, particularly for mastitis treatment.

PREPARATIONS FOR PARENTERAL AND ORAL THERAPY

Injections

The injection has two special advantages in veterinary practice. Firstly, it is usually more convenient and reliable to give an injection to an animal, especially a large animal, than it is to attempt oral dosage, even though the drug may be equally active by either route. Secondly, an injection formulation allows easy variation of the dose, enabling the veterinary surgeon to treat both large and small animals of different species, breeds, age and therefore body weight, from the same container, thereby avoiding the need to make a multiplicity of different formulations or sizes. Consequently, injections are of great importance in veterinary therapy.

Veterinary antibiotic injections differ little from their counterparts for human use, although larger packs are usually supplied to meet the bigger doses given to certain species, and for the reasons mentioned previously, multidose packs are generally preferred to single dose packs.

Antibiotic injections may be conveniently divided into two groups, depending on whether the antibiotic is administered in solution, or as a suspension of a sparingly soluble solid.

The soluble group comprises principally sodium and potassium penicillin, the tetracycline hydrochlorides, and streptomycin and dihydrostreptomycin sulphates, all of which are soluble in water. Chloramphenicol has only a low solubility in water and one manufacturer provides a companion ampoule of N-N^1-dimethyl acetamide as solvent, though these solutions are painful when injected. Neomycin, bacitracin and polymyxin so far have had only a limited use in parenteral therapy, but can be included in this group. Due to the poor stability of most antibiotics in solution they are packed as dry powders and the solution is prepared immediately before injection. Suitable buffering agents such as citrates, phosphates and glycine may also be included with the antibiotic to prolong the shelf life of the prepared solution, especially when the pack is a multidose one. By the addition of antioxidants such as sodium metabisulphite and thioglucose, streptomycin and dihydrostreptomycin solutions can be rendered sufficiently stable to have a shelf life of at least one year.

Among antibiotics injected in suspension, salts of penicillin predominate, with the procaine salt being by far the most popular, though the benzathine and benethamine salts are occasionally used. Chloramphenicol is also available as a dry powder for the preparation of an injection suspension.

The different antibiotics may be combined with one another to broaden the antibacterial spectrum or to obtain synergistic effects—this is especially important for penicillin - streptomycin formulations. Also highly soluble salts are frequently combined with a less soluble salt of the same antibiotic in order to give a high initial blood level from the soluble salt, with a lower but more prolonged level from the insoluble salt or mixture of insoluble salts. Thus a rapid peak is followed by an inhibitory concentration for 24 hr.

As already mentioned, with most antibiotics the poor stability of soluble salts in solution means that mixtures containing them must either be packed as dry powders or as oily suspensions. In the case where sparingly soluble salts are used alone, it is possible to prepare aqueous suspensions which have a shelf life of at least one year, but this type of formulation is probably the most difficult of all pharmaceutical formulation problems. As with the dry preparations, the particles must be small enough to pass through the needle of a hypodermic syringe, while crystal shape as well as size can have a profound influence on the viscosity and mobility of the suspension. Additionally the larger the particle size the lower the solubility and therefore the more prolonged the blood level. A wetting agent is usually essential in such a formulation to give good dispersion

of the particles, but the toxicity of this agent must always be considered very carefully.

An antifoaming agent may be required to reduce the foam obtained after shaking the suspension to redisperse the particles. Buffering agents are often included as with the soluble salts, and a suspending agent may be necessary especially for the ready prepared suspension type of formulation, where good redispersion is necessary even after prolonged standing. Hydrophilic colloids such as sodium carboxymethyl cellulose, polyvinylpyrrolidone and to a lesser extent the natural gums acacia and tragacanth are used for this purpose. A bacteriostat is also required in multidose containers, particularly when the product is an aqueous suspension, examples of which are phenyl mercuric nitrate, esters of *p*-hydroxybenzoic acid, and benzyl alcohol.

The package most commonly used in this country for antibiotic injections is the vial with a rubber bung or very occasionally the disposable cartridge, but disposable syringes made of glass and/or plastic and ready filled with injection have been introduced by American manufacturers where economic considerations of cost per dose are perhaps less important. The present trend is for suspension injections to be packed in free draining vials, and this is commonly achieved by applying a silicone film to the glass surface by washing with a solvent solution or an aqueous emulsion of the silicone, followed by heat treatment to give a permanent film.

Tablets and capsules

For the treatment of small animals tablets and capsules are a standard, convenient means of administering antibiotics, and the tablets and capsules intended for human therapy are generally satisfactory for small animal veterinary use, as for example in the case of penicillin V, the tetracyclines, chloramphenicol, neomycin and bacitracin. The only drawback to this method of therapy is that the human tablets and capsules are not always in the most convenient dose for very small pets such as kittens, Yorkshire terriers and chihuahuas. Additionally their use can only be encouraged where the owner can be relied upon to administer the right dose at the right time. With large animals, injections are more convenient as already mentioned, but they may be more expensive, since antibiotics are thermolabile compounds and must be manufactured and packed under aseptic conditions. If the antibiotic is absorbed from the gut or is to work in the gut, *e.g.* streptomycin, oral medication generally offers the advantage of lower cost, and one way of overcoming the difficulty of obtaining the patient's co-operation is the soluble tablet. Soluble tablets of tetracycline salts are available which can be dissolved in liquid food or drinking water, although they can be used as normal tablets when circumstances permit. Additionally, they can be used as pessaries. This multiple use idea is not always successful since veterinarians prefer one product for one job.

If treatment of an intestinal infection is necessary oral administration is preferred, and either the soluble tablet may be used or the more conventional disintegrating tablet or capsule.

Tablets for veterinary use differ from tablets for human use only in that larger tablets may be required. It is then customary to make them torpedo-shaped. Soluble tablets are preferably made with soluble binding and lubricating agents to provide a clear solution when the tablet is dissolved in water.

SOLUTIONS, SOLUBLE POWDERS, GRANULES AND DISPERSIBLE POWDERS

Tablets and capsules are essentially methods of presenting drugs in unit oral doses. As the dose required in veterinary practice varies considerably with the different species, one particular size of tablet or capsule cannot possibly meet the requirements of both large and small animals. The veterinary surgeon must therefore keep a range of tablets or capsules of different sizes for each antibiotic, although in the case of tablets they can be halved or even quartered to increase their versatility.

A means of providing a variable oral dose is by using either a concentrated solution of the antibiotic, or a powder which can be dissolved or dispersed in water. In this manner it is possible to use one product to give doses to suit all species.

Most antibiotics are not stable enough to permit solutions to be prepared which are capable of storage before use, but as described for the injection solution it is possible to provide a streptomycin with a shelf life if suitable buffers and antioxidants are included in the formulation. Instability has been overcome in the case of chloramphenicol by the use of an aqueous suspension of the insoluble palmitate ester, which is hydrolysed in the intestine to give free chloramphenicol. In a similar manner the highly insoluble benzathine salt of penicillin can be formulated as an aqueous suspension, but this salt has not found wide application in the veterinary field.

Dry powders

Dry powders are more popular because of their greater stability. If the antibiotic powder is readily soluble in water, it may be mixed with a soluble solid diluent which should be of a similar density and particle size to the antibiotic to prevent fractionation of the ingredients. To distinguish them from the pure antibiotic, soluble mixed powders of this type are sometimes tinted with a harmless dye. If the ingredients do tend to fractionate during transport, this can be overcome by granulation of the mixture as in normal tablet manufacture. Drying of the granules may present a stability problem if aqueous granulating fluids are used, in which case non-aqueous granulating solvents may be used or the granules prepared by compression of the powder followed by pulverisation of the "slugs" to give granules.

For the treatment of many intestinal infections antibiotics are often combined with other drugs, notably the sulphonamides. This gives a powder or granule which is not completely soluble in water, and the addition of a wetting agent and also a suspending agent may be necessary to give good dispersion of the insoluble portion as in the case of the injection suspension.

The tetracyclines are available as soluble powders, penicillin V as soluble granules, and streptomycin is available as a stabilised solution or combined with various sulphonamides as a powder and as granules.

The packages used for this group of products include glass bottles for liquids and some of the solids where it is desired to add water at the time of dispensing. Screw cap jars, metal canisters and metal foil envelopes are also used for the solid preparations.

(Continued on page 516)

Current Veterinary Antibiotic Products

Penicillin by Injection

Product	*Presentation*	*Indications*	*Trade name*	*Manufacturer*
Procaine Penicillin G in aqueous suspension	10 ml. vials (3 mega) 30 ml. vials (9 mega)	For production of a blood level of penicillin lasting 24 hr. after injection into the muscle	Distaquaine Mylipen Lenticillin Avloprocil (in 10 ml. and 50 ml. vials) Prostabillin A.S.	D.C.(B)L. Glaxo May and Baker I.C.I. Boots.
Crystalline Penicillin G Sodium or Potassium Salt	Vials containing 0·5, 1, 5, or 10 mega units (and other sizes)	For production of a rapid and high level of penicillin in the blood	Solupen Crystapen Penicillin B.P. Avlon Penicillin G Sodium Penicillin G	D.C. (B)L. Glaxo May and Baker I.C.I. Boots

In certain presentations this product has a citrate buffer added to prolong its stability in solution.

Other preparations of penicillin for injection are available where the formulation varies from manufacturer to manufacturer *e.g.*

Benapen—Glaxo: Benethamine penicillin in aqueous suspension.

Penidural (all purpose)—Wyeth: Combined benzathine penicillin, pot. penicillin G and procaine penicillin G.

Triplopen—Glaxo: Combined benethamine penicillin, sod. penicillin G and procaine penicillin G.

Distaquaine Fortified—D.C.(B)L.: procaine penicillin G and pot. penicillin G.

Avloprocil N.A.—I.C.I.: as Distaquaine Fortified above.

Avloprocil Oily—I.C.I.: procaine penicillin G in arachis oil.

Penidural L.A.—Wyeth: benzathine penicillin.

The above have special properties which appeal to the individual clinician. They may produce a prolonged blood level *e.g.* Benapen or Penidural L.A. or combine this with particularly high initial levels, *e.g.* Tripolen or Penidural all purpose, or a 24 hr. level with a high initial peak, *e.g.* Distaquaine fortified or Avloprocil N.A.

Penicillin with Streptomycin for injection

Product	*Presentation*	*Indications*	*Trade name*	*Manufacturer*
Combined penicillin salts with dihydro streptomycin	Vial containing pot. penicillin 0·1 mega, procaine penicillin 0·3 mega, dihydrostreptomycin sulphate 0·5 mega	For injection where the synergism resulting from this combination is of value in mixed infections	Distavone	D.C.(B)L.
	Vial containing sod. penicillin 0·5 mega, streptomycin sulphate 0·5 mega	As above	Crystamycin	Glaxo

Streptomycin for Injection

Product	*Presentation*	*Indication*	*Trade name*	*Manufacturer*
Aqueous solution of streptomycin in equal parts	A number of these solutions are available in vials containing 0·5 mega of each of the streptomycin products, *i.e.* 1 mega total in 2 ml., 3 ml. or 4 ml. of water. They are known as	For injection where streptomycin-sensitive organisms are present. The combination of the two salts is thought to reduce the toxicity	Mixtamycin Dimycin 1 : 3 Streptoduocin 1 : 2	D.C.(B)L. Glaxo Boots
	1 : 2, 1 : 3 and 1 : 4 solutions			
Aqueous solution of streptomycin sulphate	Vials containing 1 mega of salt in 2 ml., 3 ml., or 4 ml. of water	As for combined product	Streptaquaine Strepolin Strysolin 1 : 4 Streptomycin sulphate	D.C.(B)L. Glaxo May and Baker Boots

Both the above products are available in some cases in a dry powder for the addition of water. In these instances the product name is usually the same and is distinguished from the solution by the word Solution after the appropriate presentation, *e.g.* Mixtamycin and Mixtamycin Solution. In all cases where this variation of presentation is shown it is to offer a product in the dry form with a longer shelf life than the ready prepared solution. This also applies to certain penicillin products.

Streptomycin B.P. is offered by D.C.(B)L., Glaxo and Boots as the dry streptomycin sulphate powder in injection type vials of different strengths.

Oral Presentations of Penicillin and Streptomycin

Product	*Presentation*	*Indication*	*Trade name*	*Manufacturer*
Phenoxymethyl penicillin (penicillin V) tablets and suspensions or elixirs	Tablets of various strengths 60 mg. 125 mg. and 250 mg. The liquid preparations vary in presentation and strength	For oral administration of principal value in dogs, cats and some young farm stock.	Distaquaine V Penavlon V Calcipen V Penicillin V	D.C.(B)L. I.C.I. Boots Glaxo

Other oral penicillin products available before penicillin V was discovered are still in limited use, *e.g.* Crystapen—Glaxo, Penidural—Wyeth, Tabillin—Boots, Dibencil—I.C.I. Tins containing 8 oz. of penicillin granules are available from Glaxo. They are intended for therapy through admixture with the food. Additionally, Glaxo offer a stable solution of streptomycin sulphate containing 1 gramme to the ounce for oral therapy known as Streptovex.

Streptomycin combined in a dry formulation with one or more sulphonamide products is available as follows:

Entavet	Allen and Hanbury
Strinacin	May and Baker
Stromez	I.C.I.
Stredin	Bayer

These products are used for injections of the alimentary tract.

A recent introduction by the Distillers Co. is Streptaquaine Sulpha oral suspension, which is a ready prepared suspension of streptomycin with sulphadimidine, kaolin and pectin.

Apart from these products of penicillin and streptomycin, veterinary presentations of other antibiotics are also available. Chloramphenicol is available from Parke Davis and Allen and Hanbury in capsules and injection formulations. An interesting newcomer to this range from Parke Davis is Intramycetin, a ready prepared suspension of their Chloromycetin for intramuscular injection. The use of chloramphenicol for the treatment of foot rot in sheep is also considered in the presentation of an alcoholic solution of the antibiotic both in a 2 oz. bottle and from Parke Davis in an aerosol. Intramammary formulations have been dealt with in a previous article, but a new chloramphenicol product Mascetin from Parke Davis has since been introduced and is therefore worthy of mention here.

The two other broad-spectrum antibiotics, Aureomycin and Terramycin, are available from Cyanamid of Great Britain and Pfizer Ltd., respectively. Formulations include vials for injection, intramammary formulations and ointments for wound therapy. Notable products among these are the Terramycin intramammary product, which is a solution of Terramycin in propylene glycol, packed in a metal tube, and the soluble powder formula-

tions which offer these relatively expensive products in a more economical form as a powder for preparation of antibiotic solutions. These solutions can be used for treatment of enteritis in calves or diseases of poultry and are therefore both practical and versatile. They are probably the most popular of the Aureomycin and Terramycin products. Pfizer have recently introduced an injection form of Terramycin as a clear solution in propylene glycol.

This review covers the antibiotics in common use today, although there are a number of other products available containing the less popular antibiotics. These include formulations containing tyrothricin for ear conditions, bacitracin for local infections and neomycin in a remedy for enteritis from C. J. Hewlett.

Further information can be obtained from the individual manufacturer where required, and the authors would like to record their thanks to the veterinary departments of the many companies involved for their help in supplying data for this article.

The authors apologise for any inadvertent omissions in the lists and wish to make it clear that these are unintentional. The criterion for inclusion has been usage rather than availability in a special veterinary presentation.

VETERINARY ANTIBIOTICS

(*Continued from page* 514)

PREPARATIONS FOR EXTERNAL USE

Antibiotics have found use in the treatment of diseases affecting the external parts of the body. Due to the risk of insensitive strains developing during antibiotic treatment, the use of parenteral antibiotics for external diseases is tending to be replaced by antibiotics which are of limited use in parenteral therapy, and neomycin, bacitracin, polymyxin and tyrothricin are frequently included in formulations for external use, although they have not entirely superseded penicillin, the tetracyclines and chloramphenicol.

Topical ointments and eye ointments

Veterinary topical antibiotic ointments are very similar to those for medical use. Emulsion bases cannot be considered for most antibiotics due to the poor stability characteristics of antibiotics in the presence of water, but they have been used with neomycin sulphate, high potency procaine penicillin and chloramphenicol. A simple paraffin base has the advantage of inertness and cheapness with little risk of causing inactivation of the antibiotic, although it is somewhat greasy. Non-aqueous bases have been prepared with improved skin absorption properties by incorporating emulsifying agents in a paraffin base.

Local anæsthetics, such as benzocaine and lignocaine, are often included in veterinary ointments to overcome irritation which may arise, thus helping to reduce the amount of "self trauma" which animals are liable to inflict on themselves in such circumstances.

Eye ointments present little difference from those for human use. The base must be non-irritant to the eye and the antibiotics finely milled to avoid irritation, since their instability does not usually allow them to be dissolved in a small portion of water before mixing with the base as is the normal practice with soluble medicaments in eye ointments.

Veterinary ointments are packed in the normal collapsible tubes.

Dusting powders

Antibiotic dusting powders are used to a limited extent for surgical wounds and raw wounds due to injury. The preparations for human use are also used for the treatment of animals. The pure antibiotic may be applied to the wound, or it may be mixed with a sulphonamide.

A rather special additive is a mixture of amino acids claimed to help proliferation of new tissue in the wound.

Requirements which must be considered in formulation are that the powders should be sterile, free flowing and of a fine particle size. A recent introduction in Australia and North America is a powder formulation in a plastic puffer pack for insufflation into the eyes of cattle suffering from "pink eye."

Solutions

The use of antibiotics in solutions for external use is also very limited, but a number of ear preparations are available which are used in both human and veterinary therapy. Polymyxin B sulphate and chloramphenicol have been prepared as solutions in a glycol base for treating ear infections. For the same treatment, a mixture of polymyxin and oxytetracycline is available which is dissolved in a propylene glycol base containing benzocaine. The solution is prepared immediately before use, as oxytetracycline has only a limited stability in such a solvent. Ear drops of neomycin sulphate have been formulated as an aqueous solution and as an aqueous/alcoholic solution.

Chloramphenicol is also available as a 10% tincture presented in bottles or as a low-pressure aerosol for the treatment of foot rot in sheep.

In both cases the solvents are volatile, giving quick drying of the preparation on the hoof, and gentian violet is included in some formulations as a marker to define the area of application. This application of chloramphenicol for foot rot treatment is peculiar to veterinary practice and the products available appear to have sold successfully and found uses apart from foot rot.

FEED SUPPLEMENTS

Antibiotics are now being added to feeding stuffs to increase the rate of growth of young animals, in particular poultry and pigs. In this country only procaine penicillin and the tetracyclines have been used in this manner, but other antibiotics, *e.g.* bacitracin, have been used in the U.S.A. for this purpose.

In the case of the tetracyclines, the pure antibiotic is not used, but the mycelium from the fermentation process which still contains a proportion of antibiotic, forms the basis of the final product.

In the U.S.A. a rather novel way of using bacitracin for this purpose has been to prepare pellets of zinc bacitracin which are implanted in the tissue under the skin. Due to the low solubility of zinc bacitracin, together with the non-disintegrating nature of the implant, the antibiotic is only slowly released and made available for the necessary growth promotion. This development was no doubt brought to mind by consideration of the hormone implant pellets used in poultry and more recently in cattle.

REFERENCES

1. MANUFACTURING CHEMIST 1956, 27, (7), 263-5.
2. *Ibid.* 1956, 27, (12), 505-8.

RECENT DEVELOPMENTS IN *Gas Chromatography—2*

By R. P. W. Scott, B.SC., F.R.I.C.*

To conclude his article, Mr. Scott discusses high efficiency gas chromatography columns, high temperature chromatography, large preparative columns, automatic G.L.C. equipment for plant control and the application of G.L.C. to specific problems. The first part of his article appeared in October.

HIGH EFFICIENCY COLUMNS

THE resolution of a column for separating components of a mixture is a function of the retention time that the liquid phase confers on the substances eluted, and the band width of the substances as they leave the column. A common but erroneous impression is that the separation achieved is a function only of the retention time, so that if the length of a column is doubled then the difference in retention time is doubled, and an improved separation must be achieved. It may be seen from Fig. 1 that unless the peak width of the eluted sample is prevented from increasing at the same rate as the retention time increases, no improvement in the separation is obtained. Thus there are other factors that contribute to the separating power of a column besides its length, on which depends the quantity of liquid phase present.

Another erroneous assumption is that the required separation can always be obtained by finding a suitable liquid phase. Although this may be true for some simple mixtures, it is certainly not true for multi-component mixtures. It may be seen from Fig. 2 that, on a low efficiency column, benzene and *cyclo*hexane may be separated completely by using dinonyl phthalate in preference to a paraffin as the liquid phase. However, for the separation of multi-component mixture, such as a motor fuel, changing from paraffin to dinonyl phthalate affords little advantage. Changing the liquid phase merely shuffles the emerging peaks into a different order of elution, causing the benzene peak to merge with the methyl *cyclo*hexane peak instead of

* Technical Dept., Benzole Producers Ltd.

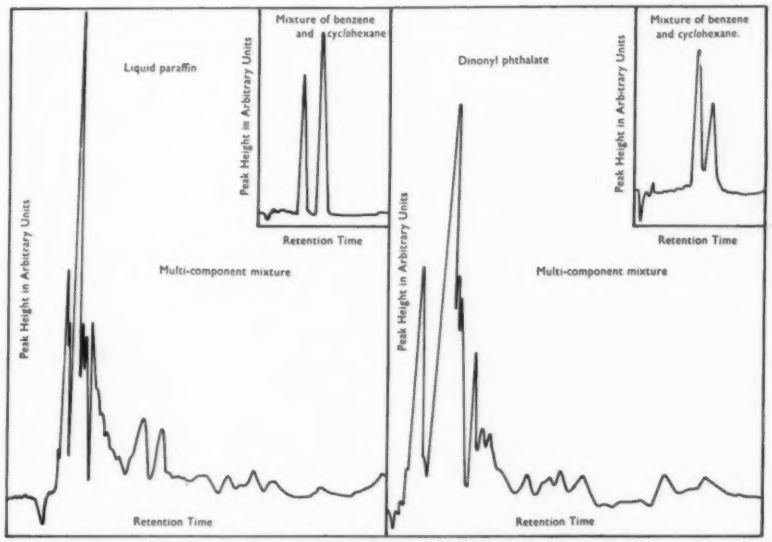

Fig. 1. The difference between retention time and efficiency.

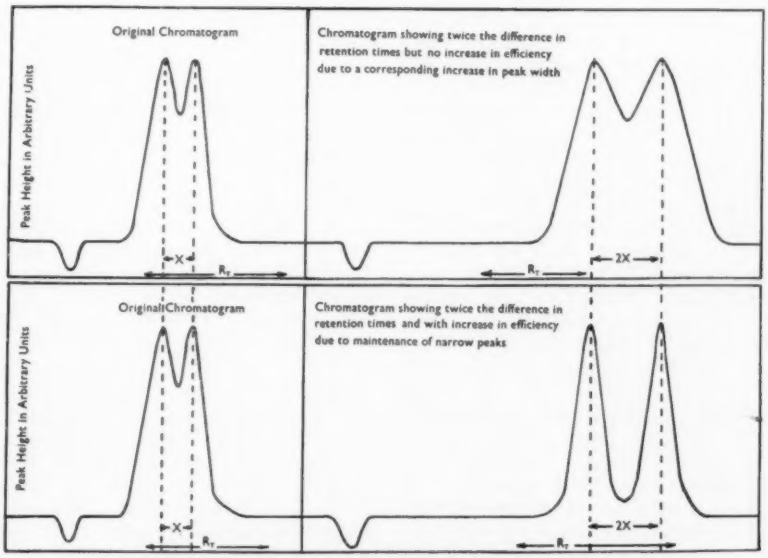
Original Chromatogram
Peak Height in Arbitrary Units
X
R_T
Chromatogram showing twice the difference in retention times but no increase in efficiency due to a corresponding increase in peak width
R_T
2X
Original Chromatogram
Peak Height in Arbitrary Units
X
R_T
Chromatogram showing twice the difference in retention times and with increase in efficiency due to maintenance of narrow peaks
R_T
2X

Fig. 2. Effect of different liquid phases on the efficiency of separation.

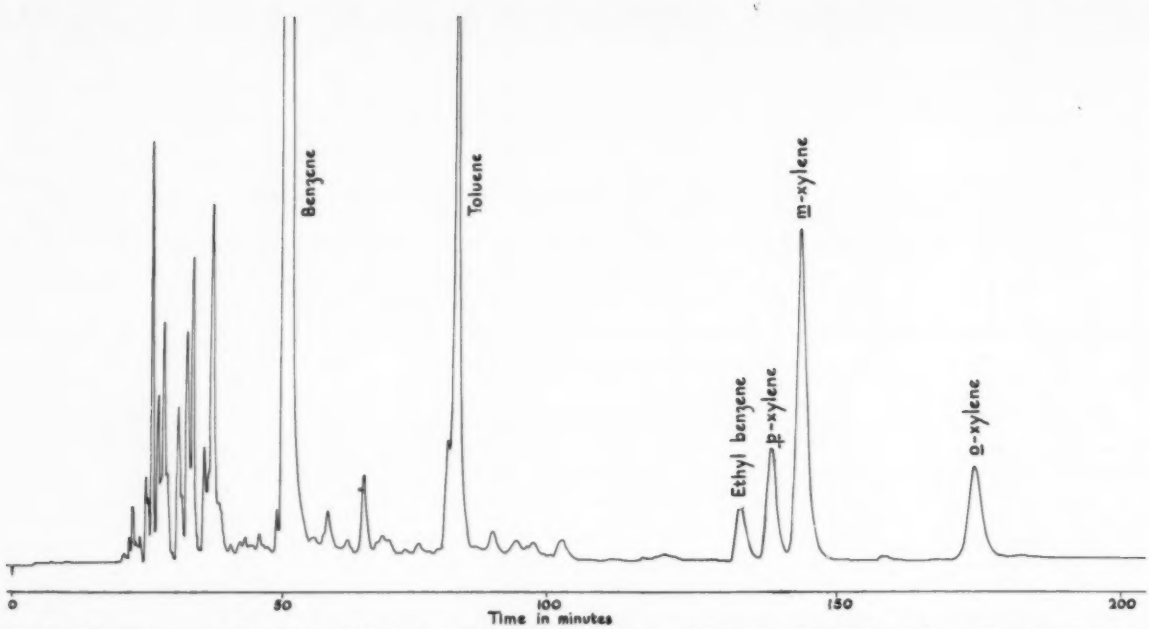

Fig. 3. Chromatograms of a "benzole" from a high efficiency column. Column length—50 ft. Column diameter—2·2 mm. Column efficiency—30,000-40,000 plates. Packing—5% w/w of polyethylene glycol dibenzoate as 100-120 firebrick. Charge—75 μg. Detector—Argon.

that of *cyclo*hexane. This effect is exemplified by the separation of the isomeric heptanes, octanes and nonanes. Attempts to separate these substances completely by searching for a suitable liquid-phase without improving the efficiency of the column used would be useless, since all the substances are so similar in character that their behaviour would be similar on all types of liquid phase.

The factors affecting column efficiency have been considered theoretically by van Deemter *et. al.*,[1] who derived the equation given in Part I of this paper. This equation has received much experimental support from many workers.[2,3,4,5] Using the conditions that are predicted by the van Deemter equation, a column of 10,000 theoretical plates was constructed by Cheshire and Scott,[4] details of which were published in March 1958. This work was extended by both Boheman and Purnell[5] and Scott,[6] both of whom produced columns with efficiencies of the order of 30,000 plates. The former authors obtained their high efficiencies by controlled packing conditions on comparatively short columns and the use of a liquid phase that had low partition coefficients with respect to the solutes eluted. These conditions resulted not only in high efficiency but produced chromatograms of comparatively short duration. The latter worker used somewhat longer columns (50 ft.) run at high inlet pressures (200 p.s.i.) and fitted with a restriction at the end of the column to reduce the inlet/outlet pressure ratio. The use of high inlet pressures coupled with a restriction at the end of the column resulted in an almost constant gas velocity and the carrier gas did not accelerate rapidly towards the end of the column. Somewhat greater efficiencies were obtained than those of Boheman and Purnell, but a heavy price was paid in elution time. An

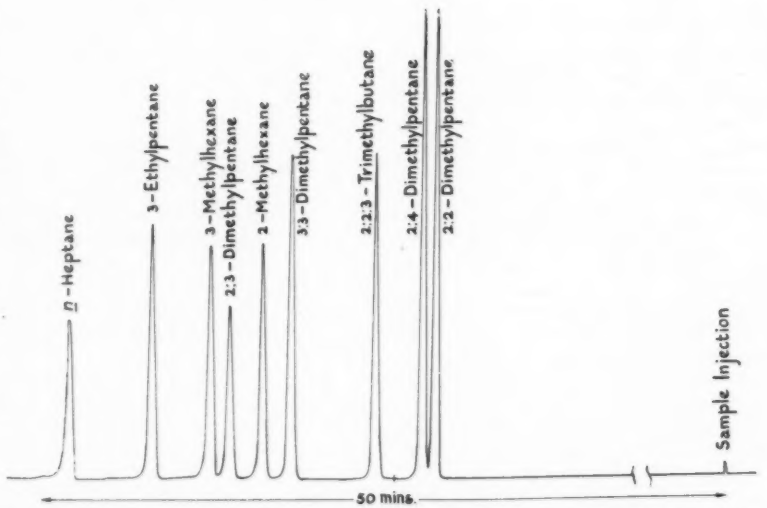

Fig. 4a. Chromatogram obtained from a capillary column of a mixture of the isomeric heptanes. Column—250 ft. 10 thou. ID copper capillary. Stationary phase—Squalane. Temperature—72°C. Carrier gas—Nitrogen. Inlet pressure—15 lb./in.² Flow rate—0·6 ml./min. Sample size—approx. 2 μg. Efficiency—106,000 theoretical plates (3-ethylpentane). Detector—Flame ionisation.

example of this is the elution time of a *p*-xylene which was six times that obtained by Boheman and Purnell on their column. A chromatogram from a high efficiency column is shown in Fig. 3.

Capillary columns

The use of capillary columns for G.L.C. was first suggested by A. J. P. Martin,[7] but the development of the theory and the application of this type of column to analysis is due to the brilliant work of Marcel Golay.[8] Briefly, the capillary column consists of a capillary tube having a diameter of about 0·01 in. and extending to several 100 ft. in length. The walls of the tube are coated with a very thin film of liquid phase by the evaporation of a solution of the liquid phase in a volatile solvent. Carrier gas flow rates of 0·5-1 ml./min. are used and 100 ft. of capillary column will have an efficiency of about 30,000 theoretical plates. Due to the small quantity of liquid phase that exists in the column, retention times are comparatively short, and analyses can be completed in a fraction of the time required by a conventional packed high efficiency column. As the small quantity of liquid phase present on the column only allows maximum charges of 1-2 μg. to be placed on the column, it is necessary to use a capillary column in conjunction with either the flame ionisation detector or the Argon detector.

The capillary column has many advantages. The apparatus is more compact, coating the capillary column is a very simple procedure compared with the packing of a conventional type column, the thermostatic bath may be small and simple to control, and high efficiencies are produced at the expense of small retention times. It would appear from results so far obtained that capillary columns must eventually supersede the conventional column for analyses. A chromatogram obtained from a capillary column is shown in Fig. 4, which includes a chromatogram of the same mixture from a conventional packed high efficiency column.

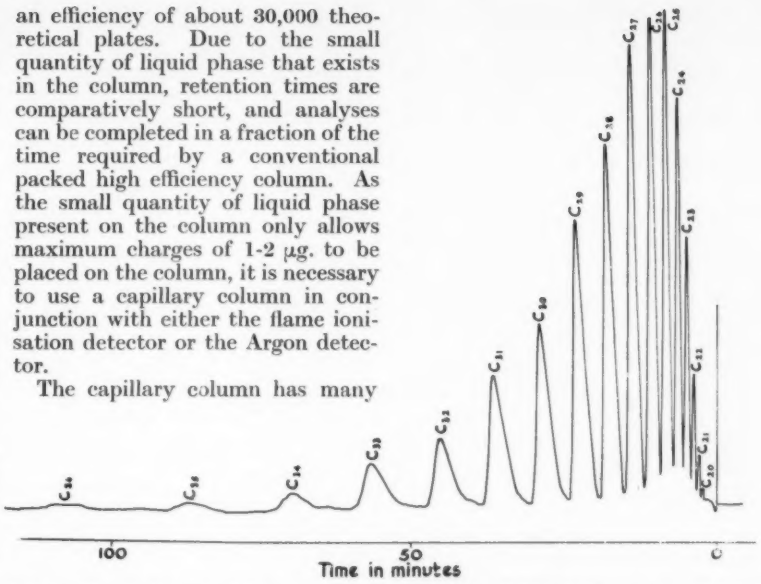

Fig. 5. Chromatogram of the *n*-paraffins contained in a light petroleum wax. Column temperature 280°C.

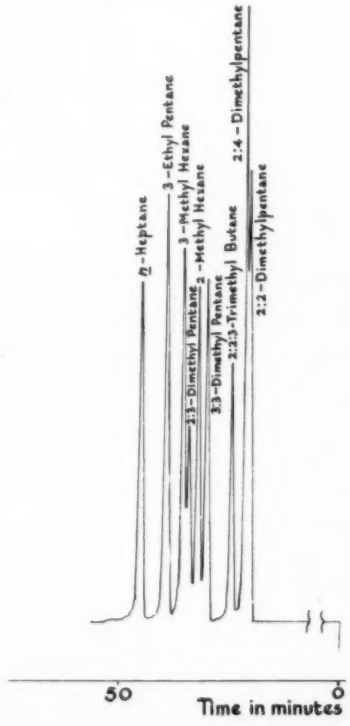

Fig. 4b. Chromatogram obtained from a conventional packed high efficiency column of a mixture of the isomeric heptanes. Column—50 ft.—2·2 mm. Stationary phase—20% w/w "apiezon" oil on 100—120 firebrick. Temperature—78°C. Carrier gas—Argon. Inlet pressure—180 lb/sq. in. Sample size—≏15μg. Efficiency — 30,000 — 40,000 plates. Detector—Argon.

High temperature chromatography

The application of G.L.C. to the analysis of high boiling substances necessitates the use of elevated column temperatures which in turn usually introduce difficulties in detector construction and stability. Davies and Johnson[9] describe an apparatus that employed the katherometer as a detector that could function up to 300°-350°C., and further work by Ashburg, Davies and Drinkwater[10] produced an apparatus that would not only function at 358°C., but could change the column temperature during a chromatogram by 100°C. or more, within a time interval of a few minutes and a final temperature control of ± 1°C. Keppler, Dijkstra and Schols[11] have also described a high temperature apparatus using the katherometer as detector that would work up to 270°C. and with it chromatographed fatty acids with carbon numbers up to C20. The density balance has also been modified to work at 300°C. by Hawks,[12] who succeeded in chromatographing diphenyl sulphone, which boils at 379°C. The most recent publication on high temperature G.L.C. was that by Adlard and Whitham,[13] who used the apparatus described by Ashburg *et al.*[10] and succeeded in chromatographing waxes with carbon numbers up to C40. These workers used an 86 cm. column with brick dust as a support, carrying a silicone grease as a liquid phase. A chromatogram obtained by these workers is given in Fig. 5, showing the separation of the normal paraffins from C_{20} to C_{36} contained in a refined light petroleum wax. Generally, substances can be chromatographed at much higher temperatures than they can be distilled. This is due to the fact that during most of the time spent in the column, the solute exists as a dilute solution in the liquid phase. In this form the solute appears to be more able to resist thermal decomposition. The limit of high temperature chromatography has yet to be reached and more progress can be expected in this field.

Analysis of wide boiling range samples

Rapid analysis by G.L.C. is restricted to samples which contain substances boiling over a reasonable temperature range. Samples of wide boiling range, chromatographed even at the best compromise of column temperature, result in sharp early peaks and diffuse late peaks. This renders the measurement of peak areas difficult with consequent poor analytical accuracy. Using fixed column temperatures the successful analysis of such samples will necessitate prefractionation into closer boiling range samples and/or the use of two columns run at different temperatures. An alternative method is to use two stage analysis or to programme heat the column. The former method uses two columns in series with a detector at the end of each column. The sample is placed on the first column and the lower boiling materials allowed to pass directly into the second column, which is run at a lower temperature. The flow from the first column is then diverted to the detector and a chromatogram of the higher boiling components obtained from the first column simultaneously with a chromatogram being produced of the low boiling components from the second column. The programme heated column has a device that continually raises the temperature of the column during the development of the chromatogram. Many workers have devised apparatus to accomplish both the two stage and programme heated analysis,[14, 15, 16. 17] the most recent being the work described by Harrison *et al.* at the Amsterdam Symposium on Gas Chromatography,[18] who has used both the two stage method and programme heating to analyse chlorinated hydrocarbon mixtures. A series of chromatograms obtained by Harrison comparing all these methods of analysing a wide boiling range mixture is shown in Fig. 6.

Large scale preparative columns

Large-scale preparative columns are required mainly for two purposes, either to produce bulk samples of high purity or to fractionate a multi-component mixture for subsequent analysis by G.L.C. or the mass spectrograph. Ambrose and Collinson[19] described the construction of a column for preparing pure samples of gases, and

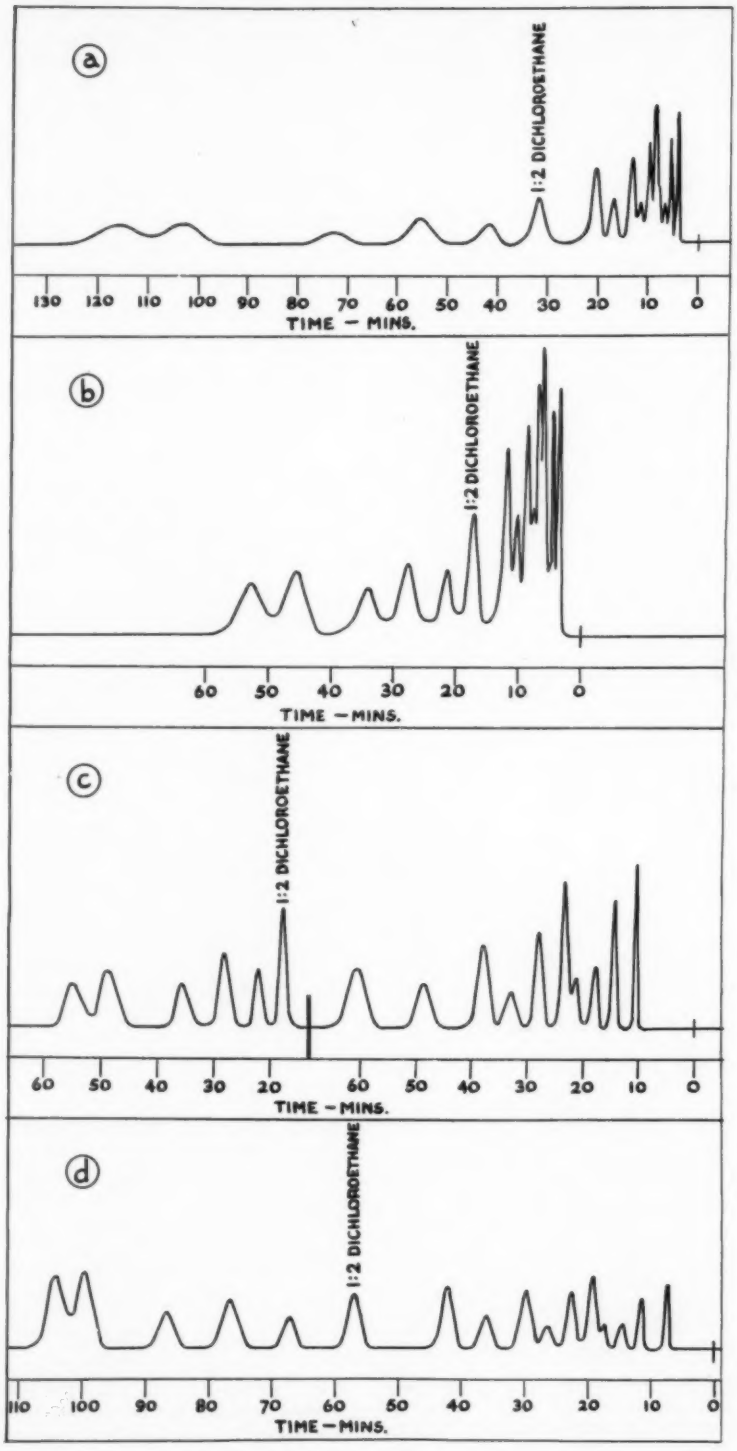

Fig. 6. Chromatograms of a complex chlorinated hydrocarbon mixture. [a] Analysis on one column at 75°C. [b] Analysis on one column at 100°C. [c] Two stage analysis on two columns at 77° C. and 55°C. [d] Analysis on one column programmed from 25°C. to 100°C.

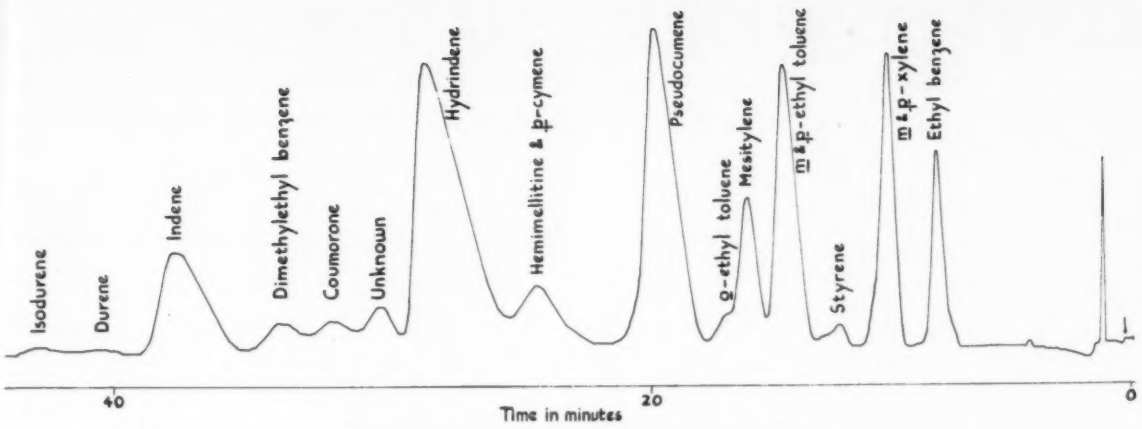

Fig. 7. Chromatogram of a coal tar naphtha fraction.

Whitham[20] published details of a column for collecting fractions of a petroleum hydrocarbon mixture for subsequent analysis. Early workers [21, 22, 23, 24] used columns of fairly large diameter and increased the column length to maintain a reasonable efficiency. This was necessary, as increasing the column diameter above 15 mm. results in a rapid loss of resolutions. Samples of a few grammes could be placed on these columns, but the retention times were very long and the columns were difficult and expensive to pack. These disadvantages were elegantly avoided by Atkinson and Tuey,[25] who constructed a column of moderate dimensions (20 mm. diameter and 300 cm. long) which was economic to pack, gave short retention times, maintained a reasonable column efficiency and could carry charges of 0·5-1 g. In order to obtain bulk samples they designed a fully automatic sampling system which was synchronised to a programmed fraction collector, so that the column would function without attention for long periods. The programmer was automatically reset at each injection, to eliminate any accumulative error over a number of injections. The programmer controlled four sample collectors each of which could be set to any chosen time interval during the elution. The following example gives an idea of the scope of this apparatus. The column was packed with celite carrying 25% w/w of silicone oil as a liquid phase, run at 100°C. with a gas flow of 400 ml./min. Injections of 0·75 g. of a test mixture containing 50% w/w toluene and 50% w/w alcohol were placed on the column every 27 minutes over a period of 18 hr. After 40 injection cycles the components from 30 g. of the sample were separated with a purity greater than 99·8% w/w.

Automatic G.L.C. equipment for plant control

The automation of G.L.C. apparatus has been largely confined to the analysis of gas samples, and in particular the hydrocarbon gas streams of petroleum refineries. The reasons for this is mainly due to the difficulties involved in constructing valves that will automatically handle small quantities of liquid samples, a few mg. in size. The main problems involve the elimination of leaks, the prevention of sample contamination and the injection of reproducible charges. The construction of valves for handling gas samples is, however, much simpler and the constructional details of several types have been published. One of the most ingenious devices designed for this purpose is that described by Hooimeijer, Kwantes and van de Craats.[26] This valve is pneumatically operated, has virtually zero dead volume in the valve itself and has a simple system for varying the volume of charge within wide limits. It is suggested by the authors that this valve could be used for sampling liquids providing the liquid was constantly vaporised and a sample of the vapour placed on the column in similar manner to a gas sample. An automatic process control unit using this valve has been in operation on a pilot plant for two years and has required little maintenance. The advantages of these automatic analysis units is not merely to assess the constancy of the product but also to supply data on transient effects occurring on the plant. Process control by automatic G.L.C. is still in its early days of development, most of the work having been done with katherometers as detectors. The incorporation of the new detector system can be anticipated together with the resulting improved separations from modified column systems.

Application of G.L.C. to specific problems

Gas chromatography can be applied to the analysis of all volatile substances. The field of application is continually widening as the technique becomes more versatile and more workers become aware of its possibilities. To discuss all the possible applications of the technique to industrial analytical problems is not within the scope of this article, but mention must be made of certain uses of the method that either are of general interest or are examples of special application that may have wider possibilities. The use of G.L.C. for the analysis of hydrocarbon gases[26, 27] and chlorinated hydrocarbons[18, 28] has already been mentioned and as an aid to the analysis of all types of hydrocarbons the technique has been invaluable. In fact, many of the new developments of the subject have come from the research laboratories of the oil companies, who were quick to see the great value of G.L.C. as an analytical tool. A novel use of the technique for investigating the fuel distributions in the cylinder of an internal combustion engine has been described by Desty *et al.* While working small samples of the vapor-

ised fuel were continually taken from each cylinder via a small hole in the cylinder head. The traces of hydrocarbons present in the sample were frozen out and analysed by G.L.C. By using a known synthetic fuel it was possible to determine the distribution of the various hydrocarbons throughout the different cylinders.

G.L.C. has been successfully used in the analysis of industrial solvents[29] and in the analysis of coal tar products. A chromatogram obtained by Grant[30] of a sample of coal tar naphthas is shown in Fig. 7. Green[31] has applied G.L.C. to the analysis of chlorofluoromethanes, and Ellis and Iverson[32] have published a paper describing the separations of the interhalogen compounds and the chromatography of uranium hexafluoride. The apparatus designed by Ellis and Iverson deserves special comment as considerable modifications in the column and associated equipment was necessary to handle such corrosive substances. All metal parts were constructed of nickel, and the column packing consisted of pulverised Teflon carrying Kel.F as a liquid phase.

Liberti and Cartoni[33] have described the analysis of some essential oils by G.L.C., but difficulties have been experienced by some workers due to adsorption of essential oil components on the support, particularly if non-polar liquid phases are used. This adsorption effect has been considerably reduced for some substances and completely eliminated for others, by silver-coating the brick dust support.[34] Silver-plating the support also increases its mechanical strength and prevents the production of fines during the addition of liquid phase. A chromatogram of an essential oil is shown in Fig. 8.

The use of G.L.C. for supplying thermodynamics and solvent data has not been explored to a great extent as yet. The most recent publication is that by Kwantes and Rijnders,[35] who determined activity coefficients for various mixtures of hydrocarbons.

One novel and not obvious application is that described by Bovijn *et al.*,[36] who have used the technique to determine hydrogen in boiling water. This elegant control method has considerable value to all power plants and the author is considering extending the method to the determination of oxygen in boiler feed water.

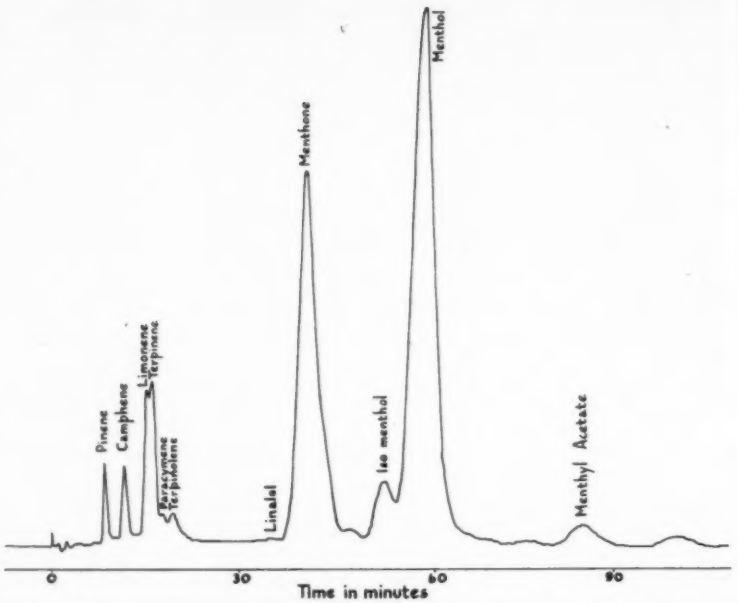

Fig. 8. Chromatogram of peppermint oil. Column length—8 ft. Column packing—Rheoplex 220 or 60-100 Silocel C22. Column temperature—162°C. Sample size—1·5μ ml. Detector—Flame.

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Acknowledgements

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ANTIBIOTICS

By R. Levin, F.P.S.

Kanamycin • Antibiotic resistance • Penicillin reactions Cancer therapy • Textile finishes • Food preservation • American manufacturers accused • Continuous fermentation

FOR antibiotics and the antibiotic industry, 1958 has been another year of change and progress and some of the more important and novel developments have been selected for review. With a history of less than twenty years, these remarkable substances have produced abundant harvests for those with the faith, imagination, ingenuity and capital necessary for the building, equipping and staffing of research laboratories and production plants. Chloramphenicol, erythromycin, neomycin, bacitracin, streptomycin, polymyxin, the tetracyclines and, of course, penicillin are among those which have performed distinguished service in medicine. The road of further progress, as those who have walked it will know well, is strewn with the corpses of the many thousands of antibiotics which failed to make the grade. Reasons for failure are several, toxicity being perhaps the most frequent; on the other hand, many erstwhile successful discoveries have suffered ultimate rejection for no reason other than the necessarily late realisation that they were already known, perhaps patented, and in some cases already in commercial production.

Kanamycin

An antibiotic which has been successful over the early hurdles and has made an impression during the year is kanamycin. Discovered in Japan in 1957[1] and derived from *Streptomyces kanamyceticus*, the substance has a wide range of antibacterial activity against many Gram-negative and Gram-positive organisms. Outstanding among these are the tubercle bacillus and the resistant pathogenic staphylococcus.

Chemically, kanamycin is related to neomycin, also having some structural features in common with streptomycin. Its antibacterial spectrum is similar to that of neomycin and resistance acquired to kanamycin may be accompanied by cross-resistance to neomycin or streptomycin, but fortunately, streptomycin-resistant strains apparently retain their sensitivity to kanamycin. Although its antibacterial activity may be likened to that of neomycin, kanamycin is considerably less toxic than the latter, indeed it has been suggested that kanamycin is slightly less toxic also than streptomycin, although as with streptomycin, damage to the eighth cranial nerve may follow prolonged administration. Kanamycin is not absorbed from the gastro-intestinal tract, excepting after the administration of massive doses; it is however rapidly absorbed from the site of intramuscular and subcutaneous injection, producing peak blood concentrations within 1 hr. Although mild renal function impairment occurs in a considerable proportion of patients receiving kanamycin, these are rarely sufficiently serious to warrant withdrawal of the antibiotic. Present experience, which is admittedly limited, suggests that eighth cranial nerve effects may be less serious than those which can occur following the administration of streptomycin sulphate, but final judgment on this issue must await the results of further prolonged trials.

Staphylococcal resistance

Although the streptomycin-resistant tubercle bacillus is a clinical problem, fortunately alternative effective anti-tubercular agents already exist. But, in the case of infections due to the resistant pathogenic staphylococcus, many patients have succumbed in spite of the use of all currently available antibiotics. The resistant staphylococcus is a growing problem particularly in hospitals where, due to cross-infection, the introduction of the organism may produce devastating clinical consequences. These, according to Langmuir,[2] comprise in particular—

(i) Skin lesions, to which the newborn are particularly susceptible and which can lead to staphylococcal pneumonia and fatal septicæmia.
(ii) Mastitis and breast abscesses among mothers following childbirth.
(iii) Potentially dangerous infection of surgical wounds.
(iv) Superimposed, life-threatening infections in debilitated patients where by virtue of a general lowering of the normal defence mechanism the patient becomes easy prey to attack from the additional foe.

Since acquired resistance of the staphylococcus is lost fairly rapidly when diluted with the non-resistant strains which make up the outside population the problem is restricted to the hospital. The limited evidence available gives hope that under the influence of kanamycin this problem may be brought under some measure of control.

Penicillin reactions

It is well known that penicillin can give rise to unpleasant side-effects. Fortunately the incidence of these reactions is relatively rare, but because the frequency does appear to be increasing, the problem, which is world-wide, is engaging the attention of the World Health Organisation.[3,4] World production of the antibiotic is now sufficient to provide more than 250 million courses of treatment (each of three mega units) annually.

Penicillin first came into general use in 1943 and the first death directly attributable to its administration was reported three years later. In 1949 a further death was described and in the succeeding years reports of fatal or near-fatal reactions have appeared with increasing frequency. In 1956 alone more than 500 severe reactions

were reported of which 81 had fatal consequences. In 1957 Welch[5] surveyed the frequency of severe reactions due to penicillin and other antibiotics which had occurred in the U.S.A. during 1954-56. He found that the number of deaths due to antibiotic administration, mostly penicillin, averaged 72 per annum. During the same period 200 tons of penicillin (equivalent to 300 million injections) were produced in the U.S.A. for human medicine. Based on this survey and on another carried out in Denmark covering the period 1951-55, the frequency of fatal penicillin reactions has been estimated to be 3 per 10 million injections.[3,4]

Severe reactions are believed to occur only in patients sensitised to the antibiotic by previous exposure, although cases have been reported in which the patient was believed not to have received penicillin in any form before the provoking dose. The way in which a sensitised person will react to subsequent exposure appears dependent on personal, constitutional factors of which little is currently understood. It seems well established, however, that patients with a personal or family history of allergy are more easily sensitised than others and react more severely to subsequent treatment. The reactions appear to have been most common in adults aged 20-49, equally between the sexes. Extremely rare in children less than 12 years, the frequency appears to decrease rapidly with increasing age above 50 years.

Antibiotics and cancer

Antibiotics act against bacteria by interfering at some stage with the normal biochemical mechanism of the organism. It is an important feature of their use in medicine that, while acting against the foreign, invasive cells, they do not harm the tissue cells of the host. For this reason it is thought they they might be useful in the treatment of cancer. Thus antibiotics such as azaserine, actinomycin, D.O.N., mitomycin, oxytetracycline, puromycin, sarkomycin and sulphocidin have been found to exert some inhibitory influence on experimental animal tumours.

Magill and his colleagues of the Sloan-Kettering Institute for Cancer Research, U.S.A., concluded from the results obtained when D.O.N. was given to 63 adult patients with disseminated malignant disease that the substance caused a transient arrest or reversal of the disease process.[6] Another Japanese discovery, mitomycin, has produced encouraging results in animal experiments. The workers concerned, who were also from the Sloan-Kettering Institute, found it to be the most effective antibiotic they had investigated. Actinomycin D was the subject of a clinical investigation by Tan, *et al.*[7] They found it to produce slight but definite objective improvement in 20% of 54 patients with various forms of cancer. When used in conjunction with X-ray objective responses were seen in more than half of 64 other patients, although some of these could have been expected to benefit from radiation alone.

Although, as already stated, it is desirable that the antibiotic should exert its anti-tumour effect without harm to the host, that happy situation has not yet been achieved. Among the antibiotics currently in use in this field anti-tumour activity is unfortunately usually accompanied by significant toxic side-effects, and in most cases these are sufficiently important to restrict the size and frequency of dosage. Although the present status of antibiotics in cancer chemotherapy is not high, Farber, an experienced American worker speaking to the Seventh International Cancer Congress held in London during July, struck an optimistic note. He was satisfied that the day would come when every malignant condition would respond to chemotherapeutic agents which were completely non-toxic to the host.

Recognising and exploiting the discovery of an antibiotic fermentation broth showing anti-tumour activity has its own problems.[8] For example, where the tumour-inhibitory fraction also appears to possess antibacterial activity, the latter property can be used for assay purposes, but it is essential to establish whether it is the same substance exerting both activities. If, as is frequently the case, the active fraction is without effect against micro-organisms, assays yielding information on fermentation and extraction must rely on anti-tumour activity and these are accordingly painfully slow.

In an endeavour to isolate one or more effective anti-cancer agents as quickly as possible, the U.S. Congress has provided academic and industrial research laboratories in America with sufficient funds for a massive and intensive crash programme. More than 100 leading U.S. pharmaceutical and chemical companies are participating in the project during which 40,000 substances, a proportion of which are antibiotics, are expected to be screened for antimitotic activity in the coming year.

Antibiotics in the textile industry

In recent years increased attention has been given to the development of textile finishes which have become known as purifying finishes. These are intended to reduce the number of micro-organisms resident in the material, thereby helping, among other things, to prevent the development of body odours. The requirements of a satisfactory finish are that it should be durable and that the active ingredient be effective at low concentrations. Moreover, it must be non-sensitising, non-allergenic, non-toxic, and should not induce the development of resistant bacterial strains. The antibacterial substance should, of course, impart little or no colour and be stable with respect to colour and activity for several months in spite of exposure to home or commercial laundering or dry cleaning. In addition the agent should not affect the "handle" of the textile and must be compatible with dyes and the other ingredients of textile finishes. Various antibacterial substances including hexachlorphene, quaternary ammonium compounds, metal complexes (*e.g.* mercury), have been tried with varying success, their major drawback being non-durability.

An unusual but nonetheless interesting and novel application of an antibiotic is that described in a U.S. patent[9] whereby the inclusion of neomycin is claimed to permit the production of a durable purifying finish, the antibiotic providing a continuing antibacterial action. In accordance with the patent neomycin becomes unusually and inexplicably substantive to a wide range of fabrics, especially those of cellulosic origin, *e.g.* cotton, cellulose acetate, wood fibres and linen. It may also be applied, but with apparently less effectiveness or durability, to wool and synthetic fibres. Specific illustrations are provided of the particular articles which can, with advantage, be treated in this manner. These include handker-

chiefs, nappies, towels, books and book covers, hospital and hotel sheets, pillow cases, hairdressers' and beauticians' cloths and washable cloth toys. Only relatively low concentrations of the antibiotic appear to be necessary to exert the desired effect, the preferred range being 0·01 to 1·0%. Washing, ironing and dry cleaning tests described in the patent suggest that in the case of the cellulosic fabrics only minor losses of the antibiotic are sustained with each of these operations.

Food preservation

When a small proportion of a suitable antibiotic is placed in uniform contact with the surface of certain foodstuffs, *e.g.* meat and fish, it is able, by exerting antibacterial activity, to suppress the growth of putrefactive organisms, thereby helping to maintain the foodstuff in a fresh condition for extended periods. Because of their wide antibacterial activity, the tetracyclines have been found to be particularly useful for the purpose and in the U.S.A. permission has been granted for the presence of limited quantities in the preservation of chicken carcasses. The antibiotic is largely or completely destroyed in cooking.

Attempts have been made to incorporate the tetracyclines into the ice used for maintaining the condition of fish immediately after the catch and during subsequent transport, but these have not always been successful. An interesting hypothesis has been offered to account for the failure which has been given practical application in the form of British patent granted to the American Cyanamid Co.[10] It is suggested there that the antibiotic can migrate away from the ice surface during the freezing operation, whereupon through lack of contact it is unable to influence the growth of spoilage organisms. According to the claims of that patent migration can be avoided by adding very small quantities of a polyvalent metallic salt and of a polymeric, water-soluble gel-forming compound to the antibiotic solution, before freezing. Calcium and magnesium salts in the proportion normally present in tap water (*i.e.* 50-200 p.p.m.) and 0·01% of one of the methylcelluloses are apparently all that is required to produce the desired effect.

U.S. antibiotic manufacturers under fire

At the instigation of U.S. Congress the Federal Trade Commission has for two years been studying manufacturers' operations and marketing methods because of accusations of price-fixing and monopoly. The FTC report[11] was published in August. Whilst most of its contents were already well known to those in the industry, interesting and illuminating points not previously published are those relating to the individual manufacturer's financial and promotion cost details and the content of hitherto secret war-time memoranda exchanged between the manufacturers. The report is largely factual, only one paragraph dealing with possible law violations. This reads:

"In its economic survey of the industry, the Commission has taken note of any situation which might represent conflict with the laws it enforces. Thus certain patents have been handled in ways that may represent conflict with anti-trust laws. Instances of uniformity of bids and unusual rigidity of prices were observed and the provisions of some term purchase drugs appear to warrant further study with respect to different prices charged to different buyers and to relationships established between the parties. All situations having a possible trade restricting aspect have been made the subject of legal investigation by the Commission since November 1957."

The implications of that paragraph were boldly stated by the FTC in a complaint alleging that the U.S. Patent Office has issued a tetracycline patent to Chas. Pfizer and Co., although the drug was unpatentable because of prior discovery. Allegations made simultaneously by the Commission were that five leading companies—Pfizer, Upjohn, Bristol Laboratories, Lederle Laboratories and Squibb—were involved in the price-fixing of certain products on arbitrary, artificial, non-competitive and rigid levels and that these companies had attempted to gain a monopoly in the field. Vigorous denials of the charges were entered immediately by spokesmen of all the companies concerned, attention being drawn to the fact that it is the margin of profit on these drugs which determines the volume of funds available for financing the development of the miracle drug of tomorrow. One comment was that if profits on all antibiotics were similar to those obtained on penicillin and streptomycin, further research on antibiotics would come to a halt. According to the president of one of the conpanies named, the average profit on its antibiotics sold in 1957 was in any case less than 1 cent per dose. The implication of the charges, particularly the extent to which the public should finance ostensibly worthy research projects, deserves greater study.

Continuous fermentation

As a production technique continuous fermentation offers many apparent advantages over batch processing. The antibiotics industry has been interested in it for some years and investigations have been carried out in several countries.

In a paper presented to a meeting of the Microbiology Group of the Society of Chemical Industry on February 21, 1957, Dr. D. Herbert of the Microbiological Research Establishment, Porton, said that the output can be adjusted to a maximum and suggested that continuous culture operated in this way should produce an output five to ten times greater than a batch process for fermenters of equal size. Using 20 litre vessels, outputs of up to 300 litres per day had been achieved, often running continuously for two to three months.

Interest in continuous fermentation is by no means confined to the antibiotic industry; for example, the Brewing Industry Research Foundation at Nutfield, Surrey, has devised an apparatus on the laboratory scale whereby fermentation can be made continuous, with fresh additions of wort constantly being made and the fully fermented beer being withdrawn daily. The process is claimed to be markedly superior to conventional brewing in speed of production—at the most favourable temperature beer is produced six times as fast under the new system. A symposium entitled "Continuous cultivation of micro-organisms" was held in Prague in June 1958; although antibiotics were not mentioned, the papers, which have now been published in English, are of interest to all who produce by fermentation.

It is known from results already obtained that many problems exist and that the overall reduction of cost may not be as large as might be anticipated. One notable difficulty is the unfortunate habit of some organisms to revert to non-antibiotic producing forms under

conditions of continuous fermentation. By judicious handling of the fermentation conditions this change may in some cases be prevented. Other important problems are contamination, need for a continuous supply of sterile mash and subsequently for continuous extraction. In other words, for the best effects continuous fermentation should be part of a continuous production process, commencing with a steady feed of raw materials and ending with equally-regular isolation of the active substance. Until all the production problems of continuous fermentation have been solved the technique cannot be adopted as a routine production method.

Bartlett and Gerhardt of the Department of Bacteriology, University of Michigan, have made a contribution which will advance thinking on this subject. In a paper presented to the Seventh International Congress on Microbiology at Stockholm in August 1958, they described the practical results they obtained when exploring the feasibility of industrial antibiotic production by continuous fermentation. They used a 40 litre vessel with a set-up designed for subsequent scaling-up to a standard production level. The medium was transferred by air pressure from a batch steriliser to a sterile hold-tank, from which it was metered by a peristaltic action pump into the aerated agitated fermenter. The crude product was air-lifted from the fermenter, separated and collected. After successful sterility and batch fermentation trials the system was first tested by producing chloramphenicol. That process was selected because of the parallel between growth of organism and antibiotic, minimum *p*H changes and favourable growth characteristics. In tests with a slow feed rate the antibiotic concentration in the effluent first fell to 30 to 50% of the original, then remained the same or rose slightly until the appearance of contamination which either stopped or reduced the yield. Penicillin production was next selected as being a process with contrasting characteristics, but trials with that antibiotic led the authors to believe that progressive reduction in yield or accumulation of mycelium in the fermenter and effluent system might severely limit single stage continuous fermentation of this antibiotic, although experimental work was continuing. Bartlett and Gerhardt have thereby illustrated some of the problems which are normally encountered.

A more optimistic note was struck by another contributor at the same Congress when he reported briefly on continuous streptomycin fermentations on the 30 and 3,000 litre scale. He had apparently accomplished runs of up to 1,000 hr. with a product yield of 75 to 80% of that normally obtained with the batch process. In a final challenging comment that speaker noted that whilst in his opinion the continuous fermentation of some antibiotics was now technically possible, industry was not yet ready to accept the method.

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Analytical Chemistry

Antibiotics • Vitamins • Alkaloids • Drugs • Pharmaceuticals
Essential oils • Detergents

By William I. Stephen, PH.D., A.R.I.C.

THE development of new antibiotics and the increasing use of established antibiotics in a variety of compounded preparations necessitates accurate methods for their analysis. A number of methods for the determination of antibiotics have appeared recently.

Antibiotics

Two volumetric methods for the determination of chloramphenicol[1] have been described. The first, a bromatometric method, depends on the reduction of the nitro-group present in the compound by heating with zinc and dilute hydrochloric acid and adding an excess of 0·1 *N*-bromine solution. After 2 min. potassium iodide is added and the liberated iodine is titrated with thiosulphate. The second method uses standard titanous chloride, an excess being added to an acidic solution of the compound. This mixture is refluxed for 5 min. in an inert atmosphere, and the excess titanous chloride is determined by titration with ferric alum. The results obtained by both methods are as satisfactory as direct chlorine determinations. A colorimetric method for this antibiotic based on the established hydroxamic acid method[2] has been described[3] and its determination by paper electrophoresis has been studied. The electrophoretic procedure carried out in an acetate buffer (*p*H 4·5) serves to separate the antibiotic from its decomposition products, and enables the direct u.v. spectrophotometric determination of the compound to be carried out on extracts of the spots on the paper.[4]

The colour test for arginine with α-naphthol and hypobromite has been used as a micro-method for the determination of streptomycin, primycin and viomycin; N-bromosuccinimide is used as a source of hypobromite.[5] Under the experimental conditions, a vivid red colour develops which is suitable for photometric measurement. The results show a relative error of 4%. The detection and determination of streptidine in streptomycin and dihydrostreptomycin is effected by electrophoresis in a borate buffer of *p*H 9.[6] The spots are developed with an alkaline nitroprusside-ferricyanide reagent which shows up the streptidine clearly if not less than 2 μg. is present. The procedure can be adapted for quantitative work.

Vitamins

The precision of the " dead-stop " method for the determination of vitamin C, particularly as applied to fruit products, has recently been improved by Curtis,[7] who has obtained accuracies within $\pm$ 0·3%. A biological and chemical method is used by French workers[8] to determine the total ascorbic acid extracted from tissue. One sample of the solution is treated with a suspension of *Erwinia solanisapra*, and after incubation the acidified solution is titrated with 2 : 4-dichlorophenolindophenol. Another sample of the solution is titrated directly with the dye, and the difference in the titres represents the dehydroascorbic acid present.

A direct method for the determination of nicotinamide in the presence of nicotinic acid is independent of the concentration of the latter.[9] The amide is coupled with barbituric acid in the presence of cyanogen bromide, and the extinction of the solution at 513 mμ is obtained. The method is sensitive to about 3 μg. of nicotinamide per ml.

A rapid method is described[10] for determining the relative purity of cyanocobalamin (vitamin B_{12}) in pharmaceuticals based on the extinction coefficients at various wavelengths. Suitable maximum values are suggested to limit the amount of " red pigment " in injections of the vitamin. A new test has been proposed to determine whether cyanocobalamin used to prepare injections conforms to the requisite U.S.P. standard of purity (95%).

Alkaloids

Langejan[12] has adapted the reaction between formaldehyde and chromotropic acid for the determination of formaldehyde liberated quantitatively on the hydrolysis of compounds containing a methylene-dioxy group, and particularly the alkaloids narceine, narcotine, cotarnine and Eupaverine. The determinations are completed spectrophotometrically at 550 mμ. The use of oscilloscopic polarography has been examined for the determination of the quinine alkaloids[13] and data are given for the depolarisation potentials. Even in 10^{-4} *M* solutions, these alkaloids are detectable.

The alkaline hydrolysis of ephedrine to give methylamine provides an easy means for the semi-micro determination of the compound.[14] The Kjeldahl method is used with satisfactory results on a variety of preparations. The detection of emetine in Dover's powder requires extraction from ammoniacal solution into benzene and re-extraction into 1% hydrochloric acid.[15] This extract is made alkaline and extracted with chloroform. The residue from the chloroform extract is dissolved in the minimum volume of ethanol and is subjected to paper chromatography with a mixture of acetone, ethyl acetate and aqueous ammonia (2 : 20 : 80) as solvent. The emetine spot is developed by the Munier reaction, by Pauly's diazo reagent, or by potassium iodoplatinate.

Banes[16] has described a simplified nitrite procedure for the determination of reserpine based on an earlier method.[17] Results are essentially the same but are obtained more rapidly. Column chromatography is used to separate the alkaloid which is subsequently treated with nitrite; spectrophotometric measurement at 390 mμ completes the analysis. Reserpine, reserpic acid and yohimbine can be separated by paper chromatography.[18] Zaffaroni's system is suitable for separating reserpine from the other two, and basic *n*-butanolic systems for the separation of reserpic acid from yohimbine. A combination of these systems enables all three alkaloids to be separated. Paper electrophoresis separates reserpine from the other alkaloids present in extracts of *Rauwolfia serpentina*.[19] Nine spots are detectable by fluorescence and certain of these are shown to arise from the presence of reserpine. Fluorimetric methods can be used to determine the amount of reserpine in the spots.

The Vitali-Morin reaction has been modified to enable the alkaloids atropine, hyoscine and hyoscyamine to be quantitatively determined.[20] The colour obtained is stable and reproducible and obeys Beer's law over the range 5-20 μg. per ml. Hydrolysis products of the alkaloids do not interfere. These three alkaloids can also be determined by titration in glacial acetic acid with perchloric acid.[21] This method can be applied particularly to crude belladonna extracts as well as preparations of the drug. The end-point is detected potentiometrically. Two colorimetric methods for these alkaloids give recoveries indicating accuracies of $\pm$1%.[22] The first depends on nitrating the residue from a chloroform extract of the material, then treating this in acetone with *iso*-propylamine. The extinction is measured at 540 mμ. The second procedure involves reduction of the nitro-compounds with zinc dust followed by treatment with sodium nitrite. The resultant solution is treated with N-1-naphthylethylenediamine and its extinction is measured at 550 mμ.

Elvidge and Proctor[23] use oxidised cellulose as an ion-exchange material to effect the separation of strychnine from extraneous material. Brucine is not separated, but both alkaloids can be determined spectrophotometrically in the presence of one another. Papaverine and narcotine can be determined by shaking a chloroform solution of the alkaloids with 2% aqueous ammonium reineckate.[24] Papaverine reineckate is precipitated and is filtered off and determined colorimetrically. The red chloroform layer in the filtrate is shaken with 1% silver nitrate and the clear chloroform layer is evaporated to yield crystals of narcotine. This can be determined by direct titration with perchloric acid in glacial acetic acid. The procedure can be applied to opium and gives reproducible results. A critical study of the 2 : 4-dinitrophenyl ether method for the determination of morphine in opium and its preparations has been made.[25] Results are in good agreement with the U.N. method and show an accuracy within 2%.

Drugs

The determination of 3-aminophenol in 4-aminosalicylic acid is based on the formation of an indamine dye when the phenol is treated in the presence of oxidants with diethyl-*p*-phenylenediamine.[26] The dye, formed from 25-100 μg. of the phenol, is extracted into benzene and the extinction of the solution is measured at 550 mμ. The dye formed from the acid is not extractable by benzene. Pethidine is determined spectrophotometrically at 257 mμ on the distillate obtained by steam distillation of the sample in aqueous solution at *p*H 8.[27] The drug can be identified by i.r. spectroscopy (1-15 μ) of the residue obtained by evaporation of the distillate. Pethidine can also be determined by non-aqueous titrimetry.[28].

Caffeine is determined photo-

nephelometrically with sodium phosphotungstate as reagent.[29] The method is suitable for determining caffeine in tea. Salvesen[30] describes the determination of caffeine in the presence of sodium salicylate or sodium benzoate by means of differential non-aqueous titrimetry. The titration medium is acetic anhydride and benzene, and the titrant is perchloric acid in glacial acetic acid. Suitable visual endpoints are obtained using colour indicators. A volumetric method is recommended for the determination of the *p*-aminosalicylate of isoniazid.[31] The sample is hydrolysed with water and the amino-acid is extracted with ether. The isoniazid is then determined iodimetrically and the amino-acid argentimetrically. A similar method has been used to determine other derivatives of isoniazid.[32]

Pharmaceuticals

A useful method for determining acetanilide in the presence of other substances such as aspirin, phenobarbitone, caffeine and codeine depends upon its hydrolysis with concentrated hydrochloric acid and subsequent titration with sodium nitrite.[33] A potentiometric titration is necessary with a platinum and a graphite electrode. The direct titration of amidopyrine in glacial acetic acid with perchloric acid using crystal violet as indicator serves to determine the compound in the presence of a variety of compounds often associated with it.[34] Non-aqueous titrimetry is also used to determine phenolic compounds.[35] The sample is dissolved in neutralised dimethylformamide and is titrated potentiometrically with tetrabutylammonium hydroxide in benzene-methanol. A similar method using methoxide as titrant is recommended for the determination of phenols in volatile oils.[36]

Phenacetin can be determined in the presence of acetanilide, aspirin, caffeine, amidopyrine or diphenhydramine by converting it first to *p*-aminophenol by treatment with hydrobromic acid.[37] This is reacted with *o*-cresol to form the coloured indophenol which can be determined colorimetrically at 605 mμ. The method is suitable for less than 10 μg. of phenacetin. A spectrophotometric method suitable for the determination of small amounts of dulcin (*p*-ethoxyphenylurea) has been described.[38] The sample solution is treated with a solution of mercuric nitrate in a boiling water bath, then cooled and oxidised with potassium persulphate. The resulting solution is examined photometrically at 550 mμ. No interference arises from the presence of a wide variety of organic materials.

Essential oils

A new colorimetric method for the determination of citral depends on its reaction in ethanolic alkali with 3 : 5-dinitrobenzoic acid.[39] The absorption of the solution at 537 mμ is then measured. The results are in good agreement with those of the hydroxylamine method for citral in lemon-grass and lemon oil. Cineole in lavender oil has been determined by i.r. spectroscopy,[40] with a reproducibility of ± 2%. Results are somewhat lower than those by the cresineol method.

In a paper chromatographic study of the separation of the constituents of essential oils, a paper impregnated with 1% of polyethylene is used.[41]

The spectrophotometric determination of αβ-unsaturated aldehydes and ketones with Girard-T reagent has been applied to essential oils.[42] Results are in good agreement with the oximation procedure for citral, cinnamaldehyde and carvone, but are lower for citral in lemon oil. The reproducibility is about ±0·5%. The polarography of some fragrant aldehydes has been reported.[43] Compounds examined are bourbonal piperonal, cyclamen aldehyde, salicylaldehyde and protocatechaldehyde.

Detergents

Non-ionic surface active agents can be identified by paper chromatography.[44] A solution of the surfactant in benzene is spotted on filter paper and developed with a mixture of *n*-butanol, pyridine and water (5 : 2 : 5). By the application of suitable reagents, the spots can be developed and eight principal non-ionic surfactants can be differentiated. Careful measurement of the R_F values enables 31 other substances to be identified.

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DETERGENTS and Detergency

By Leon Raphael, M.SC., F.R.I.C.

Soap • Tallow • Packaging • Flash drying • Rinse additives
Car washing market • Micelles

Soap fights back

LIKE every other branch of applied science, the chemistry of the soap industry remained almost static over a long period and only in the present century has any real advance been made. For a long time the process used by the ancients of boiling fats with alkali remained in use and it was only in recent years that Ittner made the first progressive step in the separation and distillation of the glycerin. Shortly afterwards, a specification for soap was published. The incorporation of additives into soap began only 30 years ago, when silicates were shown to improve the detergent action and at the same time inhibited corrosion. Laundries had always used soda ash to effect a high alkalinity, but later replaced it by meta silicate. Rancidity has always presented a problem in soap, due to the presence of unsaponified fats, and to counteract this, tin salts were incorporated during manufacture.

Just before World War II spray dried soaps were made, built with silicates and phosphates. Hexameta-phosphate and later tripolyphosphate were included to sequester the calcium and magnesium salts present in hard water. Synthetic detergents made their début shortly after World War I in the form of sulphonated naphthalene derivatives. The Germans were the pioneers in this field and went on to develop sulphated alcohols. The fatty alcohols were produced by hydrogenation of fatty esters at 300°C. over a catalyst under a pressure of about 200 atmospheres. The calcium and magnesium soaps of alcohol sulphates are themselves good detergents and this property encouraged the use of syndets in hard water areas.[1]

One of the earliest products on the market was *Dreft*, based on sodium lauryl sulphate. The *Igepons*, condensation products of isethionic acid and fatty acids, were produced by I.G. Farbenindustrie. Originally they were expensive to manufacture, but they were later able to compete with soaps.

Nacconol NR is sulphated keryl benzene which was introduced in 1933. Keryl benzene is now replaced by tetrapropylene benzene, being a more uniform product. Straight chain alkyl sulphates are better than branched chain products due to better orientation and packing at the interface.

In 1938 the sulphosuccinates made their appearance. *Aerosol* OT, the dioctyl ester of sulphosuccinic acid, is a powerful wetting agent. Since 1939 the number of synthetic detergent products has risen from 160 to over 2,000. Last year in the U.S. market 2,900 million lb. of syndets were sold, comprising 750 to 1,000 million lb. of active ingredient.

During World War II the shortage of phosphorus, benzene and sulphuric acid limited the supply of synthetics and builders. The alkyl sulphates and alkyl aryl sulphonates contain sodium sulphate as a result of their method of production. It so happens that sodium sulphate is a useful builder, improving detergent action by promoting micelle formation. After the war rapid developments in building phosphorus and sulphuric acid plants, together with the development of the petroleum chemical industry, helped to boost the syndet market. Nonionics increased with the production of ethylene oxide and were particularly useful in seawater. Lauric diethanolamide, a nonionic, enhances the foam of syndets which otherwise lack it. The use of syndets extends beyond detergency to electroplating, pigment and paper-making industries. They are also used as spreading agents in insecticides and as emulsifiers for cosmetics.

Most outlets for syndets have now been exhausted, but the toilet bar is still open to conquest. It is believed by many experts that in the United States soap will soon give way to a synthetic or partly synthetic toilet bar. Power laundries are slow to accept synthetics. Water softeners enable soap to perform satisfactorily and cheaply.

An attempt is being made by soap makers to fight back against syndets, and the possibility of incorporating EDTA (ethylene diamine tetra-acetic acid) has been seriously considered.[2] EDTA is the most efficient sequestering agent for calcium ions, and when added to hard water (100 p.p.m. hardness), reducing it to say 20 p.p.m. hardness, comparable with normal soft waters, soap behaves even more efficiently than in untreated soft water. It is still doubtful, however, whether a soap containing EDTA can compete economically with syndets. The price of EDTA has been considerably reduced, but it will need to drop much more to make the project worth while.

Tallow

The displacement of soap has been greatest in the United States, where 70% of the total soap and detergent market is held by synthetics. Although the total market has been increasing, soap production has naturally been reduced and the question arises of what to do with the raw materials, the chief one being tallow. The surplus of tallow has been further affected by a rise in meat production and as a result Americans have sought new markets. Since 1953 tallow exports from the United States have risen from a negligible amount to 1,500 million lb. a year, representing nearly half the total production. In the American Continent exports have gone to Canada, Cuba and Mexico (although the last has now stopped all tallow imports). About 60% of the tallow exports have gone to Europe, the principal importers being Italy, Germany and Belgium, and 20% to Asia, mainly to Japan. Australia and New Zealand, as meat producing countries with only a small soap industry, export a fair amount of tallow.

Table 1 summarises tallow production and uses for 1956 in the free world.[3]

Table 1. Tallow Production and Uses—1956
(million lb.)

	Production	Exports	Imports	Usage: Toilet soap	Usage: Industrial soap	Usage: Feeds	Usage: Lubricants
North America	3,243	1,591	115	425	653	215	35
South America	751	30	42	123	436	—	—
Europe	661	106	921	317	670	22	47
Asia	153	—	298	77	263	—	8
Africa/Australasia	392	223	135	65	256	—	—

About 70% of tallow is at present used for soap production. Communist countries produce about 10% of the total world production of tallow.

The changeover to syndets in countries less developed than the United States has meant a search for new uses. The production of fatty acids for food products is one important use. The fats are hydrolysed by boiling with acidic catalysts and the acids so produced are steam distilled. Other uses for fatty acids are in the manufacture of rubber, cosmetics, lubricants, emulsifiers, textiles, paper, heavy metal soaps and crude petroleum products.

Table 2 shows the change in the usage pattern of tallow since the war.[4]

Table 2. Tallow Usage
(million lb.)

	Production	Soap	Other uses
1937-41	1,200	900	300
1942-46	1,750	1,500	350
1947 ...	2,000	1,500	300
1949 ...	2,100	1,300	300
1951 ...	2,200	1,250	400
1953 ...	2,600	1,200	500
1955 ...	3,100	1,000	1,000
1956 ...	3,243	1,078	?
1957 ...	2,900	?	?

More soap in Europe

On this side of the Atlantic syndets have not captured so large a proportion of the soap market as in the United States. About 40% of all soaps and detergents are synthetic, based mainly on dodecyl benzene sulphonate, but liquid detergents using nonionics are likely to increase with the expansion of ethylene oxide production. Shell shortly expect to be producing 50,000 tons a year and other producers of ethylene oxide include Chemische Werke Hüls and Compagnie Française de Raffinage, who also make propylene tetramer for dodecyl benzene sulphonate production.[5]

Soap production has increased in Europe, despite increased synthetics usage. The chief outlets are toilet soaps, soap powders and household products. Industrial soap production showed a sharp decline. Table 3 shows the percentage increase in syndet and soap consumption relative to 1953 in a number of European countries.[3]

The per capita consumption figures of toilet soap are in line with the total soap and detergent consumption previously reported in this journal,[6] but it is significant that Italy, with a low standard of living and correspondingly low consumption of toilet soap, has shown such a remarkable expansion in its synthetic detergent manufacture. Ireland with a similarly low consumption per head of population has no synthetic detergent industry at present and its soap production actually dropped by 8%. There is, however, news of a detergent industry commencing in the Irish Republic in the near future.[7] Nearly 2,000 tons of syndets are imported annually into Ireland. The total production of syndets in 1955 in O.E.E.C. countries totalled 770,000 tons, which rose to 880,000 tons in 1956, of which 10% is exported. Figures are given in Table 4.

It is interesting to see how far ahead we are compared to other European countries in soap and detergent manufacture. In particular, our advance on the French is noteworthy in view of the fact that France was the pioneer of the European soap industry.

Packaging

The growing interest in liquid detergents, both of the light duty nonionic and the heavy duty anionic types, calls for further investigation into the packaging problem. Originally glass bottles were used, and while these continue to be popular they have the disadvantage of fragility and heavy weight. Metal containers overcome the breakage problem but raise corrosion troubles, and the need for protective lacquers increases costs. Plastics have now found a use as packages for detergents. Plastic sachets for shampoos are becoming popular and plastic bottles for detergents are being introduced. The plastics used must have low permeability for the liquids used—water, alcohol and perfumes—and the seal must withstand the pressure set up by the product under rigid conditions during transportation. Testing at various temperatures and under different conditions of humidity have been made on polythene, plasticised and stabilised synthetic rubbers, heat-sealed polyesters and polythene laminates. Polythene is still very expensive and so far the most successful plastic found useful for detergent packaging is a heat-sealable polyester fibre.[8]

Flash drying

Despite the fall off in soap production manufacturing methods continue to be improved. A problem associated with soap making is drying to the correct moisture content.

Meccaniche Moderne have developed a flash dryer for toilet soap which is designed to concentrate the soap leaving the crutcher from 63% to 80% fatty acid content.[9] It claims to give good colour and uniformity. The wet soap passes through the concentrating unit under low pressure where soap and water separate. At the exit, soap and water vapour escape into an expansion chamber through a spray-nozzle, where the soap is kept liquid by the high temperature, 105°C. Drying under these rigidly

Table 3. Soap and Syndet Consumption in Europe

	Per capita consumption of toilet soap (kg.) 1956	Percentage increase in consumption: Syndets 1954	Syndets 1955	Syndets 1956	Soap 1956
Belgium	1	40	56	65	9
France	0·5	42	102	189	8
Germany	0·9	8	29	37	8
Italy	0·4	50	125	300	0
Netherlands	0·7	16	35	20	12
Norway	0·8	12	139	186	5
U.K.	1·2	14	27	40	0

controlled conditions gives a product of uniform consistency. The complete installation, which is controlled automatically, has a capacity of 2 tons per hr. and costs about £7,000.

Rinse additives

The increasing usage and popularity of washing machines combined with the use of suitable detergents calls for investigation into possible improvements in performance. An earlier report in this series dealt with the use of cationics in after-wash treatment of fabrics to preserve their life.[6] Washing machines for dishes are becoming an established part of the equipment of large eating establishments in America and in this respect detergents are making quite a contribution. For the rapid drying of dishes, rinse additives are now used which assist rapid draining, reduce water spots and produce a brighter appearance. This is particularly useful in canteens and restaurants where speed is vital. The elimination of towelling is more hygienic and reduces the hazard of breakages. Silverware after washing takes time to drain and dry and must be packed in a vertical position. Plastic plates being hydrophobic are also slow to drain. The additives used in the rinse must be non-foaming, non-toxic, effective at low concentration, stable to high or low temperatures and unaffected by hard water. Germicidal products are a further aid to hygienic washing. The most successful additives with the required properties are nonionics. Those used are the *Spans* and *Tweens* (Sorbitol esters), *Tritons* (alkyl phenol ethers) and tall-oil esters. The sugar esters and *Pluronics* should also be very successful for this purpose. In addition to the nonionic, some additives contain alcohol or a small amount of quaternary ammonium derivative (cationic germicide).

The average area of utensils covered during one meal has been estimated, and from a measure of the amount of additive remaining after drying it is concluded that the maximum amount likely to be consumed by any man in one year is about one five-hundredth of the permissible dose—namely 70 g.—of Pluronics.[10] The additive can be injected into the dish-washing machine before the water rinse, and many automatic home dish-washers in the States have been constructed with a suitable device. It is not known to what extent catering establishments in this country are aware of the facilities offered by synthetic detergents, but there should certainly be a large untapped market.

Table 4. Exports and Imports 1956 (metric tons)

	Soap		Syndets	
	Imports	*Exports*	*Imports*	*Exports*
Austria	385	157	431	12
Belgium	1,214	2,437	10,382	5,619
Denmark	174	63	9,146	70
France	270	33,872	434	7,433
Germany	208	2,491	60	1,008
Ireland	406	33	1,925	—
Italy	154	379	—	—
Netherlands	2,832	4,517	3,680	935
Norway	87	161	—	—
Portugal	19	829	—	—
Switzerland	246	51	2,232	217
U.K.	103	54,293	—	64,847

Detergents for cars

There are now about 4 million private cars on Britain's roads, double the number of 1938. This offers an expanding market for car washing detergents. In the United States 5½ million cars are washed each week by 4,000 car cleaning services.[11] The materials used for car-cleaning include each year: 30 - 36 million lb. steam cleaners (alkaline phosphates), 30 million lb. detergents, 4 million gal. kerosene for grease removal and 1 million lb. bicarbonate. About 4 oz. of wax (usually silicone) is used on each car, amounting to 600,000 lb. total each year. In addition to the actual cleaning of the cars, detergents are used for laundering the towels used by car-washing operators, doubling the above figure. The detergents are used in liquid, paste or granular form, mainly 40% active alkyl aryl sulphonates, but also include fatty alcohol sulphates, nonionics of the nonyl phenol ether type and sulphated lauryl ethers. This business, amounting to $4-6 million a year, has given an opening to the small merchant. As profit margins are low, transport costs must be kept down and the business becomes localised.

The recession in the United States has hit the car-wash business badly. At present, only about a tenth of the car laundries are showing a sizeable profit. Nevertheless, various automatic gadgets have been introduced. One device which might compete with synthetic detergents is a machine which removes dirt by ultrasonic vibration.

Micelles[12]

The physical properties of surface active agents, such as surface tension lowering, wetting and foaming, are associated with the state of solution of the surfactant molecules. McBain studied the changes in properties of solutions and explained them as due to agglomeration of molecules to form micelles. The critical micelle concentration (C.M.C.) is the point at which rapid changes in properties occur. Within a narrow range of concentration, sharp changes take place in density, viscosity, surface tension and detergent action. Below a certain concentration no micelles are formed. Then up to the C.M.C. micelles are being formed and an equilibrium is established between ions and micelles. As the concentration of surfactant increases, the micelles become partly hydrated and gegenions form around the micelles. These are ions loosely attached to the micelles. At $0{\cdot}6 \times 10^{-3}$ molar the laurate ion is singly charged. As the concentration increases sodium ions are loosely bound to the micelles giving an increased charge, while the concentration of free sodium anions in solution decreases. The C.M.C. is in the region of $21 - 28 \times 10^{-3}$ molar. At the C.M.C. energy is liberated by the aggregation of large numbers of hydrocarbon chains with a corresponding decrease in the hydrocarbon/water interface.

There is some conflict in the theories on the shape of micelles. McBain favoured a lamellar structure, while Hartley supports the spherical shape. Other theories suggest rod-like or cylindrical shapes. There is no complete theory, but recent evidence favours a variation from spherical to plate-like structure. For measurement of the C.M.C. different methods of study give different results. The C.M.C. increases directly with tem-

(Continued on page 534)

BOOK REVIEWS

Methods of Analytical Histology and Histochemistry

By Edward Gurr. Leonard Hill (Books) Ltd. 1958. *Pp.* iv+327. 70*s. net.*

THIS book is concerned almost exclusively with the identification, by colour reactions, of chemical groups and elemental substances in microscopic preparations of tissues. It is divided into nine sections and an appendix. Section One deals with proteins and their component amino-acids; Section Two with carbohydrates and their derivatives; Section Three with fatty acids and other lipoidal material; and Sections Four, Five and Six with nucleic acids, pigments and enzymes respectively. The remaining sections describe methods for other organic compounds, inorganic substances and various technical methods.

Section Nine gives useful information on general techniques which should be particularly valuable where the methods described are being used for the first time.

The sections on the main biochemical groups are introduced by explanatory notes on the chemistry of these compounds. As is inevitable in a highly technical book of this kind, there are a few small printing slips, for instance, on p. 3 the words "*the carbon atom next to*" have obviously been missed out in the reference to *a*-amino acids. On p. 50, one of the bonds between two of the carbon acids has been left off, and on p. 99 two bonds have been omitted from one of the carbon atoms.

In an essentially practical book of this kind it may perhaps be questioned whether the inclusion of the theoretical explanations of the colour reactions will serve any useful purpose to the pharmacist, although they will undoubtedly be of considerable interest and value to other research workers.

The descriptions of the actual staining methods are clearly set out and should be readily followed even by workers not experienced in histological techniques. The appendix contains useful information on the composition of staining solutions; the inclusion of the composition of the main buffer solutions saves reference to other literature during the course of practical work. A comprehensive list of references is also included.

To sum up, this is essentially a practical manual based on Mr. Gurr's own considerable experience and it should prove of particular value to laboratories where extensive equipment and adequate library facilities are not available.

E. I. SHORT
A. E. ROBINSON

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Encyclopedia of Chemistry

Supplement. G. L. Clark, Editor-in-Chief. Reinhold, New York, and Chapman and Hall, London. Pp. 330 *inc. index.* 80*s. net.*

THIS book is a supplement to the Encyclopedia of Chemistry which was conceived as a highly condensed summary of chemical fundamentals for professionals and laymen. The range is wide, even including monographs on American organisations such as the National Bureau of Standards. It is not intended to issue further supplements. The information in this book will be included in the next, single-volume Encyclopedia.

A few monographs run to several pages. There are 14 pages on chemical process equipment, this section constituting a highly condensed primer on chemical engineering. The range of the work is indicated by the inclusion of subjects as diverse as dentifrices and annealing. There are over 200 monographs in all, written by some 150 contributors. Not everyone will agree with the selection of material, but it is, of course, always easy to criticise on this score. The number of pages is a poor indication of the wealth of information given.

Characterisation of Organic Compounds

By F. Wild. 2nd Edn. Cambridge University Press. 1958. *Pp.* 308. 37*s.* 6d. *net.*

DR. WILD'S book will already be well known to many readers of this review, as the first edition has established a place for itself as a really worthwhile publication for both advanced students and for the research worker. After two introductory chapters devoted to the selection of reagents and techniques, and to the classification of organic compounds, the bulk of the text is concerned with the practical details of the preparation of the most useful derivatives for the characterisation of individual functional groups.

Extensive tables are provided listing the physical properties of these products, and these constitute one of the most useful features of the book.

In his revision the author appears to have concentrated primarily upon the improvement of the reference data and the physical constants of many new derivatives are now listed, whilst the data for others have been revised in the light of more recent determinations. This improvement of the reference data is very valuable and the book now presents a wide range of useful information in a conveniently accessible form. Apart from this, however, a restricted comparison of the new edition with the original suggests that little or no changes have been made in the text itself, and even the pagination remains unaltered.

As the preparative instructions are primarily concerned with standard techniques this is not a serious matter for the student, but the research worker may perhaps regret that Dr. Wild has not taken the opportunity to include rather more of the advances made in this field over the last ten years.

Nevertheless this remains an excellent book and one which will be in constant use for reference purposes in many laboratories. It is well printed on good paper and is excellent value at the price.

L. J. BELLAMY.

PLANT AND EQUIPMENT

Still for Inflammable Solvents

By connecting to a steam line and feeding the exhaust steam back to a heating system, washing plant or auxiliary machine, the running costs of a new distillation unit, marketed by Liquid Systems Ltd., are claimed to be markedly reduced.

Known as the *Schlegel D.E.* 200, it comprises an insulated distilling chamber of 44 gal. capacity with a water-cooled condenser, and can be fitted with either a manual or automatic temperature regulator.

According to the manufacturers all solvents with a boiling point under 140°C. can be distilled by the use of saturated steam at 45 p.s.i.g. Liquids with a boiling point higher than 140°C. require superheated steam.

The unit is also available fitted with electrical heating elements and automatic temperature control.

A smaller model, the *D.E.* 30, is electrically heated and has a capacity of 6½ gal. Suitable for liquids having a boiling point ranging from 40°C. to 200°C., it incorporates a three-stage heating element and a thermostat which controls the heat and automatically switches off the supply when the spirit has been distilled.

Flexible Tanks

Portolite tanks—the latest development in flexible containers—have been introduced by Marston Excelsior Ltd., a subsidiary of I.C.I. Designed to provide simple, lightweight containers for the transport and storage of a wide range of liquids, the tanks are made from a range of coated strong woven fabrics and are available in a black or white finish.

Bulk liquids can be easily conveyed by normal road, rail or water transport. On the return journey the empty tank can be rolled up into a small bundle and the full load space used for other cargo.

Portolite tanks may be strapped on to the flat surface of an open-sided vehicle or placed within the walls of a vehicle with sides provided the walls are strong enough. Maximum capacity will be possible in the latter case if a tank of the right proportion is chosen. Surge can be reduced by ensuring that little or no air is allowed to enter the tank during filling. The tank is most stable when completely full; a partly filled tank should be lashed.

A " Portolite " tank ready for the road with 800 gal. on board. The tanks are made of different fabrics to suit different liquids.

Portolite tanks are suitable also for " on site " storage purposes. Their construction and flexibility enable them to be used on " unmade " ground. When not in use, they can be stored without special packaging precautions.

The tanks can be supplied with filling and emptying connections to meet customers' individual needs; the corner of the container is the most suitable place for the connection. The tanks are normally filled on the vehicle itself or on the site. Before filling, the tank should be fully rolled up to expel air. After valves and pipelines have been connected it should be rolled out completely. Filling can then proceed until the tank reaches a given height. The reverse procedure should be followed for emptying. The method of cleaning depends on the contents of the tank. Steam and detergents may be safely used, while in some cases a second fitting may help to dispose effectively of steam and condensate.

Schegel model D.E.200 still.

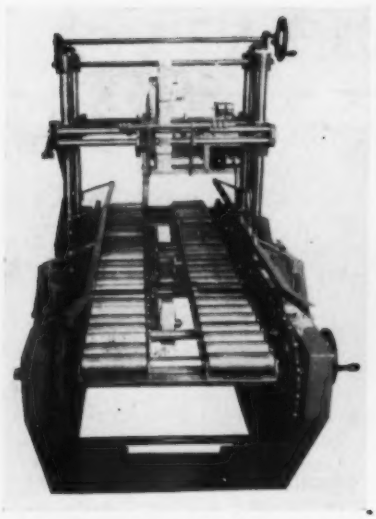
Automatic Carton Sealer

A new automatic carton sealing machine, capable of handling a variety of case sizes, with ease of adjustment and safety cut-out control, is announced by Gordon and Gotch (Sellotape) Ltd. Developed and manufactured by Adhesive Tapes Ltd., the " *U* " *Taper*, measuring 7 ft. 2 in. long, 3 ft. 10 in. wide and 6 ft. 4 in. high, has been designed to fit into a production line. It accepts fibreboard or corrugated cases with butt joining flaps of any size within the range 10 in.-20 in. wide, 7 in.-20 in. high, and 10 in.-24 in. long.

The machine applies a length of Sellotape *Vinyl* 12 tape, plain or printed, along the joining edges of the top and bottom flaps. The tape extends to vertical faces of the cartons for about 2 in. to make a seal. It takes Sellotape with a 3 in. core up to maximum roll length of 360 yd. Output is variable up to 15 a minute.

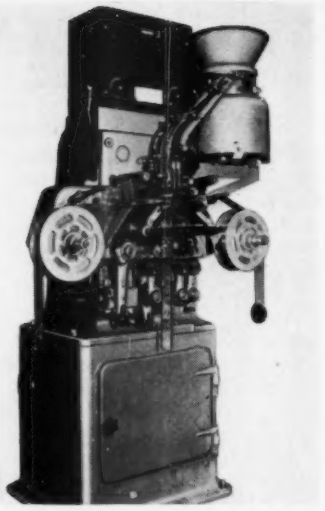
The conveyor system, driven by a 1 h.p. electric motor, comprises a series of flight bars, spaced at 3 ft. intervals, attached to a pair of conveyor chains. The cases run on conveyor rollers, and may be fed into the machine by an indexing mechanism which is an optional extra.

The forward movement of the case through the machine pulls the tape



This carton sealer, available from Gordon and Gotch (Sellotape) Ltd., will accept cases in sizes between a minimum of 10 in. by 7 in. by 10 in. and a maximum of 20 in. by 20 in. by 24 in.

A feature of this Gallenkamp melting-point determination apparatus is rapid heating by means of the boost control. The lens enables the thermometer to be easily read.



The British made Wetzel strip packaging machine. Various models are available suitable for packaging tablets, dragees, powders and liquids. An electronically controlled cut-off is fitted.

from the rolls on the upper and lower units. Applicator pads press it on to the carton, and it is cut by an electrically heated wire.

There is a single adjustment station, and it is claimed that the change from one case size to another may be made in a matter of seconds, by making two adjustments only—for width and height.

The taper is fitted with a safety cut-out which switches off the motor when a different size case enters the machine. The minimum height from floor to the top of conveyor rollers—1 ft. 11 in.—can be increased if necessary on models manufactured to fit into an existing conveyor system.

Melting Point Apparatus

Quick results and ease of reading are features claimed for a melting-point apparatus offered by A. Gallenkamp and Co. Ltd.

According to the manufacturers boost heating gives temperature increases up to 200°C. in 4·5 min., 300°C. in 9 min., and special attention to cooling gives a rapid return to normal. There is also provision for fine control of the temperature as melting points are reached.

The melting-point tubes are viewed through a large lens, so tilted that the operator may keep tubes and thermometer all simultaneously under observation. The tubes are illuminated obliquely and the background may be changed from light to dark or vice versa at a touch. The heating block takes 3 tubes, so that the method of mixed melting points may be used.

The apparatus is housed in a neat cast case, base 9 in. × 6 in., standing on rubber feet, with mains and boost switches and knob temperature control at the front.

Strip Packaging Machine

Machinery (Continental) Ltd. are now manufacturing the Wetzel type *E.W.* 102 strip packaging machine under licence from the German firm Erich Wetzel Verpackungs-maschinen. The *E.W.*102 is designed for tablets and dragees at speeds of up to 650/minute. It can also pack other items such as capsules, etc.

All machines sold are installed and set running by works engineers and maintenance engineers are quickly available to service the machines. The British Wetzel machine is built to the same designs as the German model but with certain modifications to the electrical equipment—chief of which is the incorporation of an electronically controlled cut-off which allows the length of strip to be cut to be selected or changed while the machine is still running.

DETERGENTS

(Continued from page 531)

perature according to most properties, but density variation indicates the reverse. The C.M.C. is reduced by added electrolytes and by polar solvents. Monohydric alcohols reduce the C.M.C. as the chain length of the alcohol is increased. Mixtures of soaps form mixed micelles and generally give C.M.C. values intermediate between those of the individual soaps. A mixture of two surfactants with the same C.M.C. produces no change in the value.

The study of micelles has helped in the understanding of many processes such as solubilisation of hydrocarbons and dispersion of dyes. Nonionic levelling agents form complexes with the dyes by micelle formation and an equilibrium is established between this complex and the textile fibre. This assists even dispersion of the dye on the fibre.[13]

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News . . .

Above: A night view of the new extensions. Below: The pilot plant section of the laboratories.

DUNCAN FLOCKHART'S NEW LABORATORIES

Extensions to the Duncan Flockhart research laboratories which were opened on November 14 by Prof. J. Bruce, President of the Royal College of Surgeons of Edinburgh, consist of development and biological laboratories. The former are in the chemical laboratory building which also houses the analytical control department and the library. The new biological laboratories form part of a quadrangle of buildings in which biological research and assay are carried out. The extensions were designed by members of the staff and the principal contractor for laboratory furnishing was Nathaniel Grieve.

Lord Ferrier, chairman of the T. and H. Smith Group of Companies, of which Duncan Flockhart became a member company in 1952, presided at the opening ceremony.

The research staff includes chemists, biologists, pharmacists and a medical unit headed by a physician. The programme covers analgesics, local anæsthetics, muscle relaxants and drugs for the treatment of diseases involving nervous and muscular defects.

The first major success of the group's post-war research activities was a commercial synthesis of atropine, until then obtainable only from natural plant sources, announced in January 1954. This synthesis indicated possibilities for the development of a whole series of new drugs and led in 1956 to the discovery of an entirely new compound, called *Trophenium*, for the reduction of bleeding during surgical operations. Other new compounds are on trial.

First meeting of new S.C.I. group

The inaugural meeting of the newly-formed Paper and Textile Chemicals Group of the Society of Chemical Industry took place in Manchester on October 30.

Over 100 members of the new group attended the meeting, which was opened by Dr. A. K. Mills, vice-president of the S.C.I.

Chemical Engineering Data

The 24th edition of Chemical Industries has been published by Leonard Hill Ltd., under the title *Chemical Engineering Data Book*. At a reception held to launch the book at Leonard Hill House, London, on December 2, Mr. W. Leonard Hill pointed out that the new book is a completely revised and rewritten version of his well-known publication, published originally in 1925 as Chemical Engineering Catalogue. One of his early collaborators, Prof. D. M. Newitt, F.R.S., a past-president of the Institution of Chemical Engineers, has written the foreword to the *Data Book*. The authors are Dr. T. K. Ross of Manchester College of Technology and Dr. D. C. Freshwater of Loughborough College of Technology. The *Data Book* will shortly be reviewed in this journal. It costs 84s. net.

Polymer case ends

The tribunal which has been hearing evidence in London to decide whether certain polymers had been wrongly excluded from a Board of Trade list of articles chargeable with Key Industry Duty has decided that the polymers were properly excluded from the list. I.C.I., Bakelite, Distillers and Monsanto were the complainants and the opponents included British Cellophane and Metal Box Co. The polymers concerned were polyethylene, polymethyl methacrylate, polystyrene and p.v.c.

I.C.I. statement. Commenting on the tribunal's decision, I.C.I. said the hearing did not touch on the broad issue of whether these polymers warranted increased protection. The statement continued: The present duty of 10% on the imports of these polymers into the U.K. compares with an import tariff of 25% to 35% in the U.S.A., 22% to 27% in Italy, 30% in France, 20% in Japan, and 11% to 14% in Germany.

The effect is that overseas competitors can ship materials into the U.K. market whilst a U.K. producer cannot profitably export into these high tariff countries.

Chemists Federation to be dissolved

Following the judgment of the Restrictive Practices Court that *collective* agreements to restrict sales are illegal, the Chemists Federation, in a letter to members, recommends that the Federation be dissolved in order that manufacturers and wholesalers preserve their full liberty of *individual* action to determine the distribution of their products. A meeting to discuss this recommendation was held.

Polypropylene available

Shell are now offering limited quantities of polypropylene to the U.K. plastics industry.

Shell Chemical Co. Ltd. will sell the product under the trade name *Carlona*.

New factory planned

British Oxygen Gases Ltd. have had plans prepared for the erection of a factory for the production of medical and industrial gases at Bawtry Road, Brinsworth, Rotherham, Yorks.

Stronger Cetavlon

A stronger concentrate of *Cetavlon* has been introduced by Imperial Chemical Industries Ltd., Pharmaceuticals Division. It contains 40% w/v of *Cetavlon* Cetrimide B.P. 100 ml. bottles cost 7s. 6d. and 500 ml. bottles 20s.

The 20% concentrate will still be sold.

Agents appointed

Chemicals Trading Co. Ltd. have been appointed exclusive agents for the United Kingdom of The Petrochemicals Co., Long Beach, Cal., U.S.A., producers of the water-soluble, anti-caking agents, *Petro AG*, and *Petro AG Special*, for treating powdered and crystalline chemicals. The company also produce the digester additives, *Petro P* and *Petro AA*, for the wood pulp industry.

Testimonial fund

The Proprietary Articles Trade Association are raising a testimonial fund for Mr. H. E. Chapman, the secretary of the association, in appreciation of his services to the pharmaceutical and allied trades.

Cheques should be made payable to "The H. E. Chapman Testimonial Fund," and sent to H. G. Moss, "H. E. Chapman Testimonial Fund," Fern Grove, Feltham, Middlesex.

Dispersing wettable DDT

Investigations by WHO following complaints that some shipments of DDT wettable powder were difficult to disperse have shown that this was due to two factors: (1) a reduction in the amount of anti-caking agency in the formula; (2) the removal of most of the air from the material as a result of vacuum packing.

Before mixing, lumps of the powder should be broken up either by hand or with a flat paddle or, if allowed to stand in water for about an hour before final dilution, will break up of their own accord. Another point is that compression sprayers should be shaken frequently to keep the wettable powder in uniform suspension.

Technical Press Review—December

Chemical and Process Engineering. — Evaporation; Submerged Evaporation; Synthetic Rubber Plant at Hythe; Chemical Engineering Economics; Cutting the Cost of Heavy Water; Analogue Computers in Chemical Engineering.

Corrosion Technology. — Rubber and Ebonite Lined Storage Tanks; Heavy Duty Tank Linings; Lead as a Material of Construction for Chemical Plant; Protection of Steel Drums; Aggressiveness of the Atmosphere.

Automation Progress. — Inspection After Machining; New Automatic Sizing System; Automatic Gauging; Digital Counting; Changing Over to Plated Circuitry; Remote Control in the Soviet Gas Industry; Instrumentation and Control of Ice-cream Manufacture; Control Without Mathematics; Automatic Assembly of Small Components.

Petroleum. —Protective Coatings and Cathodic Protection in the Middle East—2; Free Radical Reactions of Hydrocarbons in the Gas Phase—3; Baton Rouge Refinery.

Paint Manufacture. — Testing Marine Paints; I.C.I. Marine Research Laboratories at Brixham; Epoxide Resins Versus Corrosion; Resin Manufacture by Induction Heating.

Atomic World. — Construction Work on the Berkeley Nuclear Power Station; Selecting Nuclear Power Sites; Special Density Concrete for Shielding; High Vacuum for Nuclear Industry; Nuclear Energy in Sweden.

Food Manufacture. — Mushrooms by the Million; Mechanisation in the Cheese Industry; Measurement of the Colour of Evaporated Milk; Review of Dairy Equipment; Electrical Stunning of Pigs—2.

Dairy Engineering. — A Year's Progress in Dairy Packaging; Dairying on Display.

World Crops.—Seychelles Vanilla —1; Mechanised Cultivation on Coconut Plantations; Planting Coffee in New Areas; The Production and Processing of Rice; Papaya for Export.

Change of name

Treatt, Bovill and Co. Ltd. have disposed of their interests in Bovill Matheson and Co. Ltd., Nairobi, and have decided to revert to the company's original name of R. C. Treatt and Co. Ltd.

The company, which was established in 1886, supply essential oils and allied products.

Company finance

The Beecham Group Ltd. show a Group net profit of £1,463,000 (£1,396,000) after estimated taxation, for the half-year ended September 30, 1958. This includes the results of one month's trading by Thomas and Evans.

Unilever issue

At extraordinary general meetings of Unilever Ltd. and Unilever N.V., held on December 8 and December 1 respectively, resolutions were submitted to capitalise part of the profits retained in the businesses and to apply the amounts so capitalised in issuing Ordinary shares, credited as fully paid, to the holders of the existing Ordinary capitals of the two companies on the basis of one new Ordinary share of £1 for every £4 of Ordinary stock in LIMITED and one new Ordinary share of Fl. 1,000 for every four Ordinary shares of Fl. 1,000 in N.V.

Fison's sales and profits increase

In his annual statement, Sir Clavering Fison says that the total sales of Fisons Ltd., and associated companies, for the year to June 30 1958 were £47,391,000 (£44,750,000) and Group profit after tax was £1,594,970 (£1,516,413). A dividend of 10% is recommended on the Ordinary Capital, making a total of 15% for the year.

The trading results of the Chemical Division as a whole showed a profit for the year under review, although not a large one. During the year Fisons Pest Control Ltd. launched three new products, namely *Fisons* 1815, *Rogor* and *Blitane*, which were "conspicuously successful."

Benger's Ltd. had a successful year; in addition to a number of important and well-established medical products, the company had others in an advanced stage of development. Although the company was trading in an extremely fast moving market and one in which many unforeseen technical and commercial difficulties could arise, satisfactory progress should continue, said Sir Clavering Fison.

Genatosan Ltd. had been affected by the rise in promotional costs common to the proprietary pharmaceutical industry. During the year Whiffen and Sons Ltd. concentrated their production of industrial chemicals at their Loughborough factory and closed down the original Fulham works.

The turnover of Fisons Chemicals (Export) Ltd. again showed a substantial increase and was the largest ever achieved, particularly in Australia. There was a large increase in exports and in other income derived from the dollar account countries. This had increased nearly tenfold to its present level of nearly £500,000 per annum. Overseas expansion, particularly in Australia, Canada and India, was continuing.

People

Mr. M. J. Alberman has joined the Boards of Innoxa (England) Ltd. and Scientific Pharmacals Ltd.

Mr. A. N. Falder, personnel director of the Wellcome Foundation Ltd., has been elected to the council of the Industrial Welfare Society.

Mr. John G. Wilson, general sales manager of Universal Metal Products Ltd., has been elected to the board. **Mr J. Kenyon,** sales manager, plastics division, has been appointed general manager of the division.

Mr. K. M. N. Fergusson has been appointed a director of Evans Medical Supplies Ltd. He is the son of the chairman of the company, and is a great-great-great-grandson of John Evans, who founded the business in Worcester in 1809. Mr. Fergusson was educated at Marlborough College and qualified as a chartered accountant in 1953.

Mr. F. W. Denning has joined Rockwell Pneumatic Scale Ltd. as sales manager. He was formerly sales manager of Packaging Machinery (Peters Ltd.) at Slough and is also vice-chairman of the Southern Institute of Packaging and Chairman of the Thames Valley Branch of the Institute of Packaging.

Maj.-Gen. E. P. Readman and **Miss V. A. Pease** have joined the Board of Amber Chemical Industries Ltd. Maj.-Gen. Readman has recently retired from the post of managing director of the English Steel Tool Corp. Miss Pease has been for some time past a director of the Amber Chemical Co. Ltd. and Charles H. Windschuegl Ltd., component companies of the Amber Group. **Mr. H. N. Wigan** has resigned from the Board of the company. **Mr. J. Firminger,** who joined the company at the end of 1957, and was appointed General Manager Home Sales, is now appointed Technical Manager.

Canadian Industries Ltd. announces that **Mr. H. Greville Smith,** C.B.E., president of the company, has tendered his resignation from the board of the company effective December 31. The resignation has been accepted with great regret. **Mr. Peter C. Allen,** a director of Imperial Chemical Industries Ltd., has been appointed to fill the vacancy and has been elected President of Canadian Industries Ltd., both effective January 1, 1959. It is understood that Mr. Allen will remain on the board of I.C.I.

Mr. Greville Smith joined the former Canadian Industries Ltd. in 1932, and was elected president of that company in April 1951. He was President of the Society of Chemical Industry 1957-58.

Mr. J. Woade

Mr. K. M. N. Fergusson

Mr. G. C. R. Eley has joined the Board of the British Oxygen Co. Ltd.

Mr. J. Woade has been appointed managing director of the Blaw Knox Chemical Engineering Co. Ltd.

Mr. Leslie Williams, a member of the main Board of Imperial Chemical Industries Ltd., and **Dr. John Avery,** chairman of its Dyestuffs Division, have been appointed directors of Ilford Limited.

Mr. G. Teeling-Smith has been appointed Deputy Sales Manager of Bayer Products Ltd. He has a Cambridge Honours degree in mathematics and natural sciences, and is a member of the Pharmaceutical Society.

Mr. Stephen Crozier has been appointed Director of Public Relations, Pfizer Ltd. He will also act as adviser on public relations to the Northern European and African Area of Pfizer International Subsidiaries. He was formerly head of public relations and publicity of the Brush Group.

New oxygen factory

A new factory for the manufacture of oxygen and dissolved acetylene has been opened by British Oxygen Gases Ltd. on the Raynesway industrial estate at Derby. The company now has 46 oxygen producing and compressing centres and 20 for dissolved acetylene in operation throughout the country.

New Evans Medical company

Evans Medical (Midlands) Ltd., a subsidiary of Evans Medical Supplies Ltd., has been incorporated with premises at Kingswinford, Staffordshire, in which full stocks are carried. It has been formed to look after Evans Medical's business in the Midland Area formerly served by their Birmingham depot. The managing director is Mr. Graham A. Wilson, formerly managing director of Evans Medical (Wales) Ltd.

Blaw Knox affiliate

Blaw Knox Ltd. have formed an affiliated company, Blaw Knox Chemical Engineering Co. Ltd., 90/94 Brompton Road, London, S.W.3.

Owned jointly by Blaw Knox Ltd. of London and their associates, Blaw-Knox Co. of Pittsburgh, Pa., U.S.A., the new company will design, engineer, procure and erect process plants as well as process equipment for the chemical and petroleum industries, and serve and develop the British and overseas markets.

The managing director of the new company will be Mr. J. Woade. Other directors will be Mr. C. H. Grist, chairman, Mr. W. Cordes Snyder, Jnr. (U.S.A.), and the Hon. Alexander Hood.

Glaxo extension

Glaxo Laboratories Ltd. are extending their Cobden Street, Montrose, Scotland, premises. A new two-storey block is being constructed on ground adjoining the existing factory to provide stores, engineering shops, general office, drawing office, library and other facilities.

Reinforced plastics group formed

The British Plastics Federation has formed a new group for Reinforced Plastics. Membership of the new group is open to manufacturers who manipulate reinforced plastics and manufacturers of the materials and equipment used in the production of reinforced plastics articles.

Price's new S. African agents

Price's (Bromborough) Ltd. have appointed Imperial Chemical Industries (South Africa) Ltd. to represent them for the sale of their products in the Union of South Africa, Basutoland, Bechuanaland, Swaziland, Nyasaland, Northern and Southern Rhodesia, Portuguese East and West Africa and the Belgian Congo. The products include oleines, stearines, fatty acids, fatty alcohols and textile oils.

Pearl essence

Chemicals and Feeds Ltd. have been appointed sole U.K. agents for synthetic and organic pearl essence manufactured by N.V. Chemische Fabriek "Noord-Holland," Beverwijk, Holland. It is claimed that the material compares favourably with the best American product. Enquiries should be addressed to Chemicals and Feeds Ltd., Adelaide House, King William Street, London, E.C.4.

News from Abroad

INDIA

Streptomycin plant planned

The Government will shortly set up a plant at Pimpri, near Poona, to produce streptomycin and dihydrostreptomycin. An annual production of 45,000 kg. is planned. It is expected to go into production by the end of 1960 or early 1961. A consultant service agreement has already been signed with a U.S. firm. Present imports of these two drugs stand at 32,000 kg. p.a., costing Rs. 12 million. There are about 2·6m. TB victims in India.

First explosives factory

India's first commercial blasting explosives factory was opened on November 5, by the President of India, Dr. Rajendra Prasad, at Gomia, Bihar.

The factory has been built by Indian Explosives Ltd., a company which was formed in 1953 and in which Imperial Chemical Industries Ltd., through their Indian subsidiary company, are in partnership with the Government of India.

I.C.I.'s Nobel Division have been responsible for the design, erection and commissioning of the plant, which will have a capacity of 5,000 short tons of explosives a year. A scheme to produce safety fuse at the same site has been licensed by the Government of India. The factory site, which covers 2,000 acres, is close to the coalmines of Bihar and Bengal, major consumers of commercial explosives.

UNITED STATES

Magnus dinner

Civic, banking and business leaders attended a dinner in New York, in honour of Percy Cecil Magnus, president, Magnus, Mabee and Reynard, Inc., on the occasion of his 65th birthday on October 22. The hosts were his brothers, Joseph Baird Magnus and Robert Burke Magnus, Sr.

Pituitary growth hormone

Growth hormone extracted from human pituitary glands at autopsy is said to have added more than 3 in. to the height of an 11-year-old girl pituitary dwarf. The successful use of the drug is reported by Dr. C. H. Li, director of the University of California's Hormone Research Laboratory according to *Medical News*, a publication of Ciba Pharmaceutical Products Inc. Drs. J. J. Hutchings, R. F. Escamilla and W. C. Deamer of the University Medical Centre, San Francisco, are credited with the successful clinical use of the hormone.

Croda developments

Croda Inc. of New York, the U.S. subsidiary of Croda Ltd., England, have acquired the whole of the issued capital of the Hummel Lanolin Corp., a company recently formed to take over the lanolin and wool grease division of the Hummel Chemical Co. Inc. Hummel Lanolin Corp. will function as a subsidiary of Croda Inc.

A modern lanolin manufacturing plant has been set up in Newark, N.J., to supply lanolin and lanolin derivatives to Croda Inc. and Hummel Lanolin Corp.

This new plant is the latest of a number of lanolin processing units which Croda has set up in England, Italy and Belgium.

E. Merck venture

Stauffer Pharmaceuticals Inc. has been established as a joint venture between Stauffer Chemical Co. and E. Merck AG., Darmstadt, Germany. The new company will make bulk quantities of several pharmaceuticals and fine chemicals in the E. Merck line and will market them in the United States and Canada.

E. Merck-Darmstadt is one of the oldest firms in the pharmaceutical industry, tracing its origin to a pharmacy founded in 1654 in Darmstadt, Germany. The main plant and research laboratories are still in that city.

Stauffer produces a varied range of industrial and agricultural chemicals in 51 plants throughout the United States. In 1957 the company had a turnover of $157 million.

Histidine available

General Mills, Inc., research laboratories have produced on a commercial scale L-histidine monohydrochloride N.F. and L-histidine free base. Both are recovered from natural sources by means of a special process developed by the company's chemists.

Because of the high degree of functionality imparted by its imidazole group, histidine should be especially attractive for a variety of chemical preparations, particularly peptide synthesis. For example, a histidine-based polypeptide has been synthesised which is reported to be approximately three times more active than a related natural enzyme.

The free base is very weakly basic, and the hydrochloride is moderately acidic. The hydrochloride is approximately four times more soluble than the free base.

Although not an amino acid essential to man, histidine has been tried out medically, for example, to enhance the formation of thrombocytes, to alleviate allergy, pain, digestive disturbances, and peripheral vascular disease. Experimental animal work has also been reported in which it aids corneal tissue rebuilding, lowers blood cholesteral and is useful in combating hepatitis.

FRANCE

Reichhold factory

Reichhold-Beckacite S.A. of Bezons near Paris plan to build an additional factory to produce basic chemicals and synthetic resins. The new plant is to be constructed on a 95,000 sq. metre property in the industrial section of Niort, near Bordeaux, and is scheduled for completion by midsummer 1959.

Reichhold-Beckacite S.A. is a subsidiary of the American concern Reichhold Chemicals Inc. With 38 factories throughout the world (including 11 plants in Europe), Reichhold's sales in 1958 are expected to reach $150 million.

AUSTRALIA

Vinyl acetate plant

A new vinyl acetate plant capable of supplying the total Australian demand has gone into production on the C.S.R. Chemicals Co. site at Rhodes, New South Wales. It cost some £500,000, and is the first vinyl acetate plant to be constructed in Australia. It operates through an agreement with British Celanese, who supplied the " know how " and technical assistance, and is working 24 hr. a day seven days a week. It requires a labour force of only one man per 8-hr. shift, plus the supervisory staff which is shared by three nearby acetyl plants.

Western Australian imports

A year's imports of drugs and medicinal preparations into Western Australia from the United Kingdom are listed as follows: penicillin, £106; streptomycin, £2,431; bacteriological products and sera, £16; caffeine and its salts, £263; drugs of plant origin, £119.

Insulin, £1,157; liver extracts, £38; phenacetin, £985; quinine and its salts, £81; strychnine and its salts, £1,143; theobromine, £32; vitamin B12, £319.

Other vitamins and vitamin preparations, £61; sulpha dimidine, £4,039; other sulpha drugs, £520; and various drugs and medicinal preparations, £33,765.

New Products

Moisture balancer

Coty (England) Ltd. are marketing a " vitamin moisture balancer " which is claimed to keep the skin at a correct moisture content. Made in two types, one for dry and normal skins and one for oily skins, the balancer contains a new lanolin derivative and vitamins A, D and E.

★

Diuretic

Esidrex™ (dihydro - chlorothiazide), a new oral diuretic developed by Ciba Pharmaceutical Products Inc. of Summit, New Jersey, is reported to have been used successfully in relieving œdema associated with high blood pressure, congestive heart failure and other diseases. The product is said to have little or no tendency to add to the possible complications of corticoid treatment of rheumatoid arthritis and, used alone, has been found capable of controlling high blood pressure in some patients. In others, the new drug has been found to enhance the antihypertensive action of other drugs.

★

For geriatric care

A new preparation from Vitamins Ltd., *Juvel*, is intended for the treatment of nutritional insufficiency in older patients. It is claimed to present the vitamins most needed by persons beginning to experience the disabilities of old age.

Dosage is one or two tablets daily and the formula of the product is as follows: vitamin A 5,000 i.u.; vitamin D_2 B.P. 500 i.u.; aneurine hydrochloride 2·5 mg.; riboflavine B.P. 2·5 mg.; pyridoxine B.P.C. 2·5 mg.; nicotinamide B.P. 50 mg.; tocopheryl acetate B.P.C. 10 mg. and ascorbic acid 50 mg. *Juvel* is available in packs of 100 and 500 tablets.

★

Colourising shampoo

Essentially a nitro-dye incorporated in a shampoo, *Focus*, made by Toni Cosmetics, is a semi-permanent colour highlight for the hair.

According to the manufacturers the dye penetrates the hair so that one application lasts for five or six weeks. Although it will not change the basic colour of the hair, it gives a " bright colour " or highlight.

Six different shades are available: golden glint, chestnut sheen, hazel gleam, auburn lights, copper lustre and dark glow, each of which is numbered and packed in cellophane-wrapped cartons of a different colour.

Packaging

Dispensing unit for bottles

The *Pressa-Flo* dispensing unit, manufactured by Lee Plastics Ltd., consists of a bulb constructed on the bellows principle and has a base which can be pressed into many sizes of bottle openings.

The bellows are compressed while the dispenser is inserted into the bottle neck and then released. Gentle pressure on the bulb then brings a flow of liquid from the dispenser. A 4 ft. length of polythene tubing is supplied for attachment to the appliance.

★

Puffer pack for powder

The Crooke's Laboratories Ltd. are selling their *Episol* dusting powder in a *Poly-Tainer* flexible bottle made by the Plastics Group of the Metal Box Co. Ltd.

The bottle is one of the standard range of *Poly-Tainers* fitted with a puffer and a polystyrene cap. The bottle is of natural polythene and is printed with a brand name, details and directions for use, in lavender. The cap is white.

★

Visible packaging

How can the maker best safeguard glassware in transit from warehouse to customer ? Q.V.F. Ltd. claim to have found an answer; they have designed a pack which lets the goods handler see what is inside the packing case.

A typical design is a packing case for a 6 in. borosilicate glass condenser. This has half-windows of expanded metal on three sides of the case and overall dimensions of 44 in. by 20 in. by 20 in., with a packed weight of 83 lb. The condenser is spring-mounted in a rectangular cradle which fits inside the actual packing case.

★

Bag sealer

The *Amazon* bag-neck sealing machine available from John Gosheron and Co. Ltd. is approximately 9 in. by 6½ in. by 2½ in. and can be used with cellulose, vinyl, p.v.c., polythene, paper and certain cloth self-adhesive tapes up to widths of ½ in. on 3 in. cores (1 in. cores can be specially supplied).

The sealing unit is a simple, yet strong, spring-loaded mechanism which can be replaced when necessary. In operation the bag neck is pushed down between two spring-loaded blades and at the same time a piece of tape is automatically wound around the bag neck. As the bag is brought up and withdrawn the tape is severed and an effective seal is made. The *Amazon* sells at £6.

Correspondence

Dollar Technology in Britain

To The Editor.

SIR,—In your September issue under the heading " Dollar Technology in Britain " you review the book " American Investment in British Manufacturing Industry " by Dr. J. H. Dunning, which we publish. Your reviewer quotes a table from this book which contains an unfortunate error, since it lists the firm of Laporte Chemicals Ltd. as being a fully-owned American subsidiary. This is not the case, the firm being in British ownership, and we should be most grateful if you would draw your readers' attention to this error which both the author and we much regret.

Charles Furth,
Director.
George Allen and Unwin Ltd.
*London, W.C.*1.

Meetings

Institution of Chemical Engineers

January 20. " Separation of Isotopes," by P. T. Nettley. 7 p.m. The Blossoms Hotel, Chester.

Royal Institute of Chemistry

January 19. " Chemistry of Poisoning," by A. S. Curry. 7.30 p.m. Enfield Technical College, Queensway, Ponders End, Middx.

The Chemical Society

December 17. " Polysaccharides Today," by Prof. P. S. O. Colla. 7.45 p.m. Chemistry Department, University College, Dublin.

Society of Chemical Industry

January 5. " Electronic Computers in the Chemical Industry," by C. M. Berners-Lee. 6.30 p.m. 14 Belgrave Square, London, S.W.1.

Microbiology Group

January 14. " Differential Media." Joint meeting with Society for Applied Biology. Papers by Dr. L. A. Allen, Dr. E. Barnes, Dr. B. Hobbs, Drs. Beech and Carr, Dr. J. Postgate, Dr. M. E. Sharpe and G. Smith." 2.15 p.m. Royal Society of Medicine, 1 Wimpole Street, London, W.1.

January 15. " Bacterial Cell Wall Components," by Prof. J. Baddiley. 7.30 p.m. Imperial College of Science and Technology, London, S.W.1.

THE CHEMICAL MARKET

CAUSTIC CHEAPER: OTHER HEAVY CHEMICALS DOWN

LONDON.—**Aluminium stearate** is down to £253 6s. per ton; **acetic anhydride** to £128 per ton; **calcium chloride** to £16 17s. 6d. per ton; **caustic soda** to £35 16s. 6d. per ton and **soda ash** to £17 3s. per ton. **Silver nitrate** is down to 5s. 0$\frac{5}{16}$d. per oz. Refined, deodorised **palm kernel oil** has gone up to £146 per ton and **palm oil** has increased to £103 per ton. Dar-es-Salaam spot **beeswax** is reduced to £26 10s. per cwt.; **carnauba,** prime spot, is reduced to £50 per cwt.; and fatty grey to £28 per cwt. **Gum arabic,** lump, is reduced to £7 5s. cwt.

FINE CHEMICALS

Acetanilide 12½ kg. 7s. 4d. kg.
Arsenious oxide B.P.
7-lb. lots 1s. 9d. lb.
1 cwt. lots 1s. 2d. lb.
Ascorbic acid
100 kg. £4 14s. kg.
Aspirin
56 lb. 5s. 2d. lb.
1-cwt. 4s. 11d. ,,
5-cwt. lots 4s. 9d. ,,
Atropine
Sulphate, 500 g. & £59 18s. 6d. kg.
Alkaloid, 500 g. £69 10s. kg.
Benzene B.P.C. 28-lb. lots 1s. 8d. lb.
Benzoic acid 12½ kg. 7s. 4d. kg.
Benzyl benzoate
According to pack 5s. to 5s. 6d. lb.
Bismuth oxide B.P.C. 1934
28-lb. lots 26s. 10d. lb.
Bismuth salts 28-lb. lots:
Carbonate 22s. 3d. lb.
Subgallate 21s. 1d. ,,
Salicylate 21s. 9d. ,,
Subnitrate 20s. 5d. ,,
Borax B.P.
Powder (hessian bags) £58 10s.
,, (paper bags) £57 10s.
Extra fine (hessian bags) £59 10s.
,, ,, (paper bags) £58 10s.
Boric acid B.P.
Crystal (hessian bags) £96 10s.
,, (paper bags) £95 10s.
Powder (hessian bags) £94
,, (paper bags) £93
Bromine B.P.C.
7-lb. lots 6s. lb.
Caffeine 50 kg. 42s. 6d. kg.
Calamine 50 kg. 4s. kg.
Calcium gluconate
1 cwt. lots dlvd. 3s. 7d. lb.
Calcium glycerophosphate
50 kg. 28s. 6d. kg.
Calcium lactate B.P.
7-lb. lots 3s. 6d. lb.
1-cwt. lots 2s. 11d. ,,
Chloral hydrate 50 kg. 10s. kg.
Citric acid, B.P.
Powder or granulated:
1-cwt. lots £11 5s. cwt.
5-cwt. lots £11 ,,
Codeine
Alkaloid 100 g. £106 7s. 6d. kg.
Phosphate 100 g. £110 ,,
Cream of tartar
1-cwt. lots £11 15s. cwt.
5-cwt. lots £11 13s. ,,
Ephedrine 500 g. lots
Hydrochloride 3 kg. £6 12s. 3d. kg.
Alkaloid 3 kg. £12 7s. kg.
Sulphate 3 kg. £6 12s. 3d. ,,
Eucalyptol
1-cwt. lots 11s. lb.
5-cwt. lots 10s. 6d. ,,
Ferri ammonium citrate B.P.
1-cwt. lots, scales 4s. 7d. lb.
1-cwt. lots, granules 3s. 9d. ,,
Ferrous gluconate
1 cwt. lots dlvd. 6s. 3d. lb.
Gallic acid B.P.C.
1-cwt. lots 10s. ,,
Glycerophosphoric acid
24 litres 11s. 10d. litre
Glycine (amino acetic acid)
12½ kg. 18s. 10d. kg.
Hexyl resorcinol 10 kg. £7 10s. kg.
Hydroquinone 12½ kg. 23s. 10d. kg.
Iodides
Ethyl
4 kg. bottles 62s. 9d. kg.
Mercury, red B.P.C.
28-lb. lots 27s. 1d. lb.
1-cwt. lots 24s. 9d. ,,
Potassium B.P.
28-lb. lots 8s. 0d. ,,
1-cwt. lots 7s. 3d. ,,
Sodium B.P.
28-lb. lots 13s. ,,
1-cwt. lots 12s. 9d. ,,
Iodine, Chilean crude,
99% min. in wooden casks 15s. kg.
Iodoform
12½ kg. and under 50 kg. 42s. 6d. kg.
Lactose 50 kg. 3s. 2d. kg.
Lithium salts 5-cwt. lots
Benzoate 10s. lb.
Carbonate B.P.C. 11s. 3d. ,,
Chloride (commercial) powder 11s. ,,
,, granular 10s. 9d. ,,
Hydroxide 9s. 9d. ,,
Citrate B.P.C. 9s. ,,
Sulphate 8s. 6d. ,,
Salicylate, 10 cwt., dlvd. 9s. 9d. ,,
Magnesium carbonate B.P.
Light cwt. lots dlvd. £129 ton
Magnesium trisilicate
28-lb. packages
28-lb. lots 4s. 3d. lb.
1-cwt. lots 3s. 10d. ,,
5-cwt. lots 3s. 7d. ,,
Bulk rates for larger quantities are from 3s. 1d. lb. in 1 ton lots
Manganese hypophosphite B.P.C.
7-lb. lots 13s. 11d. lb.
1-cwt. lots 12s. 11d. ,,
Mercuric chloride B.P.
50-kg. lump 48s. 6d. kg.
Methyl salicylate 1-cwt. lots 3s. 3d. lb.
Morphine
Alkaloid, 100 g. £138 18s. 4d. kg.
Nicotinamide 1 kg. £3 15s. kg.
Nicotinic acid
12½ kg. 52s. 6d. kg.
1 kg. 55s. ,,
Oleine, B.P. extra pale, 3/4 cwt. drums returnable carriage paid G.B. £160 ton
Phenolphthalein 50 kg. 24s. 3d. kg.
Phosphoric acid B.P.
(s.g. 1·750) 10 carboy lots 1s. 4d. lb.
Potassium permanganate B.P.
1-cwt. lots dlvd. 1s. 11¼d. lb.
Procaine hydrochloride (foreign) 2 kg. 59s. kg.
Quinine 1 oz. lots 4s. 4d. oz.
Riboflavin
100 g. 5½d. g.
10 g. 7d. ,,
Saccharin
500 g. £7 4s. for this quantity
Salicylic acid
B.P., dlvd. 3s. 2½d. to 5s. 6d. lb.
Silver nitrate
500 g. 5s. 0$\frac{5}{16}$d. oz.
Sodium benzoate B.P.
1-cwt. lots 2s. 9½d. lb.
1-ton lots 2s. 7½d. ,,
Sodium salicylate
50 kg. 8s. 8d. kg.
12½ kg. 9s. ,,
Sodium thiosulphate
Crystals, photographic quality
1-ton lots 49s. cwt.
Stearic acid B.P.C. flake, carriage paid G.B. £154 ton
Strychnine 25 oz.
Alkaloid 8s. 6d.
Hydrochloride 8s. 6d.
Sulphate 7s. 6d.
Sulphaguanidine
12½ kg. 33s. kg.
50 kg. 32s. ,,
Sulphanilamide
12½ kg. 16s. 6d. kg.
50 kg. 15s. 4d. ,,
Sulphathiazole 12½ kg. 39s. 9d. kg.
Tannic acid B.P. Levis
1-cwt. lots 10s. lb.
Tartaric acid B.P.
Powder or granulated,
10 cwt. or more £14 10s. cwt.
Terpineol, B.P.
40-gal. drums 2s. 5d. lb.
1-cwt. lots 2s. 8d. ,,
Theophylline, B.P.
500 g. 27s. 6d. for this quantity
Thiamine hydrochloride
100 g. 4d. g.
1 kg. £13 7s. 6d. kg.
Thioglycollate
Ammonium 12s. 4d. to 16s. 4d. lb.
Calcium:
7-lb. lots 17s. 3d. ,,
5-cwt. lots 14s. 3d. ,,
α-Tocopherol 25-g. lots 1s. 1d. g.
Vanillin 26s. to 30s. 6d. lb.
Zinc oxide, B.P.
2-ton lots £112 ton

GENERAL CHEMICALS

Acetic acid 1-ton lots dlvd.
80% Technical £99 ton
80% Pure £105 ,,
Glacial B.P. £114 ,,
99-100% Glacial £111 ,,
98-100% Glacial £108 ,,

Acetic anhydride
1-ton lots dlvd. £128 ton

Acetone
5-gal. drums, free, non-returnable £128 ton
40 to 45-gal. drums, 10-ton lots £88 ,,

Alum, potassium granular crystals
50 kg. 1s. 2d. kg.

Aluminium hydroxide B.P.C. 34
28-lb. lots 2s. 4d. lb.

Aluminium stearate
(Precipitate) 1-ton lots £253 6s. ton

Ammonia
Persulphate £6 2s. 6d. cwt.
Phosphate: Mono- £106 ton
Di- £100 ,,

Amyl acetate
B.S.S. 10 tons and over £251 ton
Technical £249 ,,

Amyl alcohol
Technical in 1-ton lots £260 ton

Arsenic White powdered ex store £37-£38 ton

***n*-Butyl acetate**
10-ton lots £173 ton

***n*-Butyl alcohol**
10-ton lots £149 ton

Calcium chloride
Solid 70 to 72%, 4-ton lots dlvd. £16 17s. 6d. ton

Calcium oxide (Lime)
Ex marble 28-lb. lots 3s. 10d. lb.

Caustic soda
Solid 1-ton lots, from £35 16s. 6d. ton

Chloroform B.P. ½-ton lots 3s. 1½d. lb.

Chromic acid
Dlvd. U.K. (less 2½%) 2s. 0½d. to 2s. 0¾d. lb.

DDT 3s. 0½d. to 3s. 2d. lb.

2 : 4-Dichlorophenoxyacetic acid
99% pure, 1-cwt. bags £330 ton

Dimethyl sulphate 400 lb. drum lots 1s. 8d. lb.

Ether (Diethyl ether)
Tech. B.S.S. and Solvent B.P. 1-ton lots in drums 2s. lb.

Ethyl acetate 10-ton lots £145 ton

Ethyl alcohol
95% Gay Lussac 66·0 o.p.
2,500 to over 300,000 proof gallons per year in tank wagons 4s. 2¾d. to 4s. 0½d. per proof gal.

Ferrous sulphate 50 kg. 1s. 4d. kg.

Formaldehyde
40% by volume dlvd. England 1-ton lots £38 15s. ton

Glycerin
1,260 s.g. chem. pure, 5 tons and up, 5-cwt. drums £201 10s. ton
1,260 s.g. refined pale straw, indus., 5 tons and up, 5-cwt. drums £196 10s. ton

Hexamine
1-ton lots
Technical, bulk 1s. 8d. lb.
B.P.C. 1s. 11d. ,,

Hydrochloric acid
Commercial 18s. 6d. cwt.

Hydrogen peroxide
27·5% weight £128 10s. ton
35% weight £158 ,,

Lactic acid (1-ton lots)
Pale tech. 44% by weight 1s. 3½d. lb.
Dark tech. 44% by weight 9½d. lb.

Magnesium chloride
Solid (ex wharf): 1-ton lots £17 10s. ton

Magnesium sulphate £14 10s. to £15 5s. ton

Mercurous chloride (calomel)
50 kg. 65s. kg.

Mercury sulphide, red
Ton lots and over 30s. 6d. lb.

Methylated spirits (Industrial)
Perfumery quality 500 gal. and upwards:
61 o.p. 7s. 4d.
74 o.p. 7s. 11½d.
5 to 10 gal.:
61 o.p. 8s. 8d.
74 o.p. 9s. 3½d.

Methyl ethyl ketone
10 tons dlvd. in drums £14[illegible] ton

Methyl isobutyl carbinol
10 tons and up, in drums, dlvd. £163 ton

Methyl isobutyl ketone
10 to 50 tons, in drums, dlvd. £169 ton

Naphthalene
Crystal, dlvd., 4-ton lots, spot £65 4s. 3d. ton
Ball and flake (ditto) £73 14s. 3d. ,,

Nickel sulphate
dlvd. ton lots £195 10s. ton

Nitric acid 70% intermediate £32 ,,

Pentachlorphenol
Flake, technical, 1-ton lots, dlvd. 2s. 2d. lb.

Phenol Crystals:
Under 1 ton dlvd. from 1s. 7d. lb.
10 tons and over dlvd. in returnable drums from 1s. 4½d. lb.

Phthalates
10 ton lots in drums
Diethyl (B.S.) £187 10s. ton
Dimethyl (B.S.) £179 ton

Potassium bromide
50 kg. 5s. 6d. kg.
12½ kg. 5s. 8d. ,,

Potassium carbonate
Calcined 96 to 98% (1-ton lots ex store) £76 ton
Hydrated (1-ton lots) £74 10s. ,,

Potassium fluoride
28-lb. lots 5s. 1d. lb.

Potassium sodium tartrate
5-cwt. lots £10 cwt.

Soda ash
1-ton lots dlvd., from £17 3s. ton

Sodium cyanide
96-98% £128 ton

Sodium hydroxide 28 lb. lots:
sticks (1 lb. bottles) 4s. 3d. lb.
pellets ,, ,, 3s. 9d. ,,

Sodium metal 28-lb. lots 3s. 8d. ,,

Sodium metasilicate
Dlvd. U.K. in ton lots £26 ton

Sodium phosphate
Dlvd. ton lots: Di-sodium, crystalline £40 10s. ton
Anhydrous £88 ,,
Tri-sodium, crystalline £39 ,,
Anhydrous £86 ,,

Sodium silicate
according to quantity, grade and delivery point
4 ton lots £13 10s. ton
1 ton lots £15 ,,

Sodium sulphate Ex works:
(Glauber salt) £13 ton
(Salt cake) unground, full truck loads £8 16s. 6d. ton

Sodium sulphide
Broken, returnable drums, dlvd. ton lots £37 2s. 6d. ton
Flake, ditto £38 12s. 6d. ,,
Solid ditto £36 2s. 6d. ,,

Sodium sulphite
Commercial crystals 4-ton lots £24 10s. ,,
(Dlvd. London in 1-cwt. single non-returnable bags)

Sodium tripolyphosphate
1-ton lots £95 ton

Stannic chloride 28-lb. lots 8s. 11d. lb.

Stannous chloride 28-lb. lots 9s. 5d. lb.

Strontium carbonate
96-98% 28-lb. lots 3s. lb.

Sulphuric acid, ex-works, according to quality and quantity
B.O.V. 78% from 8s. to 10s. cwt.
C.O.V. 96% from 11s. to 14s. cwt.

Zinc chloride
28-lb. lots sticks 6s. 9d. lb.

OILS AND FATS

Palm kernel oil
Refined, deodorised, 2-ton lots, naked, ex works £146 ton

Palm oil
Refined, deodorised, 2-ton lots, naked, ex works £103 ton

Stearine
dlvd. free bags
Pristerene 64 flake £148 ton
Pristerene 62 flake £133 ,,
Pristerene 61 flake £113 ,,
A premium of £2 ton is charged for powder and £4 for block

GUMS AND WAXES

Agar Agar No. 1
Kobe strip 11s. 9d. lb.
Powder 17s. 0d. ,,

Beeswax
Dar-es-Salaam spot (nominal) £226 10s. cwt.
Sudan spot (duty paid) £26 ,,
Bleached white (slab) £31 ,,
Refined yellow (slab) £28 ,,

Benzoin
Sumatra spot £27 cwt.
Siam spot £2 7s. 6d. lb.

Candelilla Spot £24 cwt.

Carnauba
Prime, Spot £50 cwt.
Fatty grey £28 ,,

Gum arabic Lump £7 5s. cwt.

Karaya Powder, Spot 3s. 6d. lb.

Paraffin wax
1-ton lots, acc. to grade £87 10s. to £120 ton

Peru balsam 11s. lb.

Shellac
No. 1 orange £13 cwt.
No. 2 orange £11 10s. ,,
Transparent white 4s. 3d. lb.
Pale dewaxed 6s. ,,

Tragacanth
No. 1 spot £127 10s. cwt.
No. 2 spot £121 ,,
Pale leaf £50 ,,
Amber £38 ,,
Brown to Red £28 ,,

NEW COMPANIES

These particulars of new companies have been extracted from the daily register of Jordan and Sons Ltd., company registration agents, Chancery Lane, London, W.C. 2.

S. Davies Dispensing Chemists Ltd. 8.10.58. 3 The Broadway, Brighton Rd., Worthing. £250. Dirs.: J. Jocz-Yates and C. A. G. Hawkins.

Marginsons (Whitestake) Ltd. 8.10.58. Royalty Lane, Whitestake, nr. Preston. Chemists, druggists, opticians, etc. £1,000. Permt. dirs.: C. Marginson, B. C. Marginson, R. C. Marginson, J. C. Marginson and G. C. Marginson.

Griffiths Chemists (Pembroke Dock) Ltd. 9.10.58. 19 Dimond St., Pembroke Dock. £1,000. Dirs.: H. S. and Mrs. L. Griffiths.

T.C.I. Ltd. 13.10.58. 159 Stoke Newington High St., London, N.16. Mnfrs. of and dlrs. in chemicals, gases, drugs, etc. £100. Dirs.: H. W. Childs and C. H. Moore.

Cymbalist Ltd. 13.10.58. Chemists, herbalists, seedsmen, etc. £100. Subs.: M. A. and Millie Cymbalist, 16 Belmont Court, Temple Fortune, London, N.W.11.

Summerhayes (Chemists) Ltd. 14.10.58. 72 Norbury Rd., Thornton Heath, Surrey. £100. Dirs.: Mrs. F. J. and E. H. Spalding and R. V. Owen.

R. A. Sheldrake Ltd. 15.10.58. 35 Appleton Gate, Newark on Trent. Chemists, etc. £5,000. Dirs.: R. A. and Doris Sheldrake.

E. G. Drake (Chemists) Ltd. 20.10.58. 1 Buttershaw Lane, Buttershaw, Bradford. £2,500. Dirs.: E. G. and Mrs. M. Drake.

A. Polozynski and Co. Ltd. 21.10.58. 103 Manningham Lane, Bradford. Chemists and druggists, etc. £5,000.Dirs.: J. Klupt and A. Polozynski.

Darley and Trask Ltd. 21.10.58. 237 Hoxton St., London, N.1. Chemists and druggists. £2,500. Dirs.: E. A. Darley and G. C. Trask.

N. A. W. Edwards and Co. Ltd. 21.10.58. Chemists, druggists, etc. £500. Subs.: N. A. W. Edwards and F. D. Pontet, 4 Francis St., London, S.W.1.

Phillips Nunney and Co. Ltd. 30.10.58. 36 Mackenzie St., Slough. To take over bus. of dispensing chemists cd. on at Plaistow, London, E.13, by C. J. Nunney and Co. (Chemists) Ltd. £100. Permt. dirs.: J. Kent, C. J. Nunney, E. D. Phillips and W. B. Jordan.

Chemical Experts Ltd. 30.10.58. Chemical and pharmaceutical research experts, inventors and developers of and dlrs. in chemical and pharmaceutical preparations, etc. £100. Sub.: H. C. Davies, 11 Old Jewry, London, E.C.2.

Vanity Shop Ltd. 31.10.58. 10 Regency Parade, London, N.W.3. Chemists, dlrs. in chemists' sundries, etc. £3,000. Dirs.: S. Benghiat and S. Memran.

V. A. Henderson (Chemists) Ltd. 3.11.58. 1 Sheffield Rd., Dronfield. £5,000. Dirs.: V. A. Henderson and Dora I. R. Watkins.

NEW TRADE MARKS

APPLICATIONS

Cosmetics, toilet preparations

GALAXY.—770,217. *Gala of London Ltd.*

SWANDOWN TEEN AND TWENTY MAKE-UP.—776,039. *Henry Tetlow Co. Ltd.*

COTILLION.—776,279. *Avon Products Inc.*

COTY BLUSH PINK.—775,402. *Coty (England) Ltd.*

BISKREEM.—779,433. *Andomia Products Ltd.*

F. MILLOT.—764,439. *Société Technique de Parfumerie F. Millot.*

CUPIDON.—767,954. *Regal Stationery Co. Ltd.*

EMERALD.—B769,371. *Alfred Hopps, Sons and Co. Ltd.*

DU-ART.—B771,824. *Duart Manufacturing Co. Ltd.*

FOCUS.—775,179. *The Gillette Co.*

COTY COMPATIBLE RED.—775,401. *Coty (England) Ltd.*

PORCUPINE.—777,238. *C. W. L. Developments Ltd.*

WELLA-FIX.—777,321. *Wella Rapid Ltd.*

WELLAFORM.—777,322. *Wella Rapid Ltd.*

WELLATON.—778,292. *Wella Rapid Ltd.*

SUMMER GOLD.—778,403. *Boots Pure Drug Co. Ltd.*

GALA VELVET FINISH.—763,403. *Gala of London Ltd.*

TRESPORT.—776,174. *Maison Tschanz Comptoir de la Parfumerie S.A.*

VITACRIN.—777,275. *The International Import and Export Corp. Ltd.*

NEW PATENTS

COMPLETE SPECIFICATIONS ACCEPTED

Pharmaceuticals

Synthesis of glutamic acid and intermediates therefor. *E. I. Du Pont de Nemours and Co.* 806,798.

Pyrimidine derivatives and a process for the manufacture thereof. *F. Hoffmann-La Roche and Co. A.G.* 806,584.

Pharmaceuticals. *E. Merck A.G.* 806,714.

Diaminoquinazolines and method of preparing. *Wellcome Foundation Ltd.* 806,772.

Heterocyclic sulphonamides. *May and Baker Ltd.* 806,812.

Salicylic acid 2, 6-dimethyl-4-*n*-propoxybenzoate. *Upjohn Co.* 806,499.

Pharmaceutical compositions. *Imperial Chemical Industries Ltd.* 806,722.

Alkaloids. *S.A. Sorelux.* 806,691; 806,692.

Aminopyridazone - (6) - compounds. *Ciba Ltd.* 806,635.

Substituted urea compounds and process for producing same. *Parke, Davis and Co.* 806,338.

Phenthiazine derivatives and processes for their preparation. *Soc. des Usines Chimiques Rhone - Poulenc.* 805,886; 805,887.

3 - Substituted - 8 - alkylnortropanes and the acid and quaternary ammonium salts thereof. *Smith Kline and French Laboratories.* 805,885.

Organic compounds containing phosphorus and sulphur and processes for their manufacture. *Ciba Ltd.* 805,931.

Imidazoline salts and a process for the production thereof. *Dr. A. Wander A.G.* 806,060.

N - [β - (*o* - chlorophenyl) - β - (hydroxy) - ethyl] isopropylamine. *E. Lilly and Co.* 805,576.

L-Gutamine synthesis. *International Minerals and Chemical Corp.* 806,146.

Production of tropine derivatives. *Sandoz Ltd.* 805,859.

Tertiary alcohol derivatives of 8-alkylnortropanes and the acid and quaternary ammonium salts thereof. *Smith Kline and French Laboratories.* 805,883.

Production of 3-substituted 4-hydroxycoumarins and the 1-thia analogues thereof. *J. R. Geigy A.G.* 805,748.

New patents are from the *Journal of Patents*, and new trade marks are from the *Trade Marks Journal*. In each case permission to publish has been given by the controller of Her Majesty's Stationery Office. Each of the publications mentioned is obtainable from the Patent Office, 26 Southampton Buildings, London, W.C.2.

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From MANUFACTURING CHEMIST, December 1898

We are informed that a considerable quantity of the so-called rice powder largely used by ladies is adulterated with white lead, chalk, starch, arsenic, carbonate of bismuth, etc., in varying properties, and no small amounts of the paralysis now so frequently complained of in groups of muscles in the face is attributed by a medical contemporary to the continuous use of this highly dangerous toilet concoction.

MANUFACTURING CHEMIST
and Manufacturing Perfumer

Index to Volume XXIX, 1958

A.B.C.M. Annual dinner, 488
A.B.P.I. annual dinner, 217
"Accident Prevention in a Modern Factory," 324
Acetyl-strophanthidin (*p.r.*), 434
Activated carbon, moulded, 355
"Acyl Halides, Synthesis and Applications of," by G. Machell, 428, 473
Advertising claims, 134
Advertising in a technological age, 315
Aerosol containers, "official" medicines, 444
Aerosols, cosmetic aspects (*p.r.*), 482
"Aerosol Cosmetics, Formulation of," 232
African pyrethrum (*l.*), 198
"Agricultural Sprays, Wetting Agents for," by J. S. Stanley, 334, 385
"Air Conditioning Plant, Selection of," by D. Hackett, 420
"Air Conditioning Requirements of the Pharmaceutical Industry," by D. R. Dickenson, 417
Air conditioning:
  Airmonitor, 424
  calcium sulphate drying, 426
  climatisers and dehumidifiers, 423
  coolers, 423
  dehumidifiers, direct, 424
  dust removal, 426
  electrostatic precipitation, 426
  filters, 425
  filters, asbestos sheet, 425
  "heat and air" plant, 424
  humidity control, 424
  space conditioning, 423
  ultra-violet deodorisation, 426
  vertical units, 423
  water chilling, 427
Air fresheners, evaluation, 59
Air pollution, W.H.O. conference, 3
"Alcohol and Alcoholometry," 347
Allantoin (*p.r.*), 206
Allenburys factory for Iran, 399
American industry in Britain, 365
Amœbiasis, Glaucarubin for (*p.v.*), 434
Ampholytic surface-active agents, 51
Anæsthetics:
  ataralgesia, 87
  m-Butoxyphenyl-β-(*N*-piperidyl)-ethylketone (*p.r.*), 251
  local (*p.r.*), 251
Analgesics (*p.r.*), 156, 249
Analgesics, Wyeth research, 504
Analysis:
  alkaloids (*p.r.*), 160, 527
  alkyl benzene sulphonates (*p.r.*), 207
  anionic surface-active agents (*p.r.*), 77
  antibiotics (*p.r.*), 160, 298, 526
  antibiotics, chromatography (*p.r.*), 78
  antihistamines (*p.r.*), 297
  crude drugs (*p.r.*), 297
  detergents (*p.r.*), 161, 299, 343, 528
  drugs (*p.r.*), 297, 527
  essential oils (*p.r.*), 77, 160, 299, 476, 528
  ethylene oxide in condensates, titrimetric analysis, 338
  fine chemicals (*p.r.*), 158, 299
  fungicides (*p.r.*), 299
  herbicides (*p.r.*), 161
  hormones (*p.r.*), 160
  insecticides (*p.r.*), 299
  insulin (*p.r.*), 160
  pesticides (*p.r.*), 77
  perfume intermediates (*p.r.*), 299
  pharmaceuticals (*p.r.*), 78, 159, 298, 528
  photographic chemicals (*p.r.*), 159
  salicylic acid detection (*p.r.*), 79
  spectroscopy of cosmetic creams (*p.r.*), 206

GUIDE TO PAGE NUMBERS

January	**1-46**	**July**	**269-314**
February	**47-92**	**August**	**315-360**
March	**93-132**	**September**	**361-406**
April	**133-176**	**October**	**407-450**
May	**177-224**	**November**	**451-498**
June	**225-268**	**December**	**499-548**

Article headings are in quotation marks.

Key to abbreviations: Abstracts (abs.), Reference in Progress Report (p.r.), and Letters (l.).

The following group headings are used.

Air conditioning, Analysis, Antibacterials, Antibiotics, Book Reviews, Company finance, Cosmetics, Detergents, Disinfectants, Essential oils, Fertilisers, Fungicides, Hormones, Insecticides, Instruments and apparatus, Packaging, Perfumery, Pesticides, Pipes and pipework, Plant and equipment, Protective clothing, Safety, Surface-active agents, Weedkillers

Analysis (*continued*)
  sulphonamides (*p.r.*), 78
  vitamins (*p.r.*), 78, 160, 526
Analyst's achievements, 407
"Analytical Chemistry," by William I. Stephen (*p.r.*), 77, 158, 297, 526
Anorexiant (*p.r.*), 250, 433
Antibacterials:
  Clorpactin bactericidal wash (*p.r.*), 480
  from plants (*p.r.*), 75
  penicillin:
    milk residue hazard, 93
    reactions (*p.r.*), 250
  phenolic compounds, interaction on bacteria (*p.r.*), 390
  Pipradol (*p.r.*), 389
  virulence boosting (*p.r.*), 391
  Warexin (*p.r.*), 481
"Antibiotics," by R. Levin (*p.r.*), 523
Antibiotics:
  Agri-mycin, for hop mildew (*p.r.*), 157
  aureomycin refining, 181
  Biostat for whale preservation, 93
  cancer therapy, 135, 524
  continuous fermentation (*p.r.*), 525
  food preservation (*p.r.*), 525
  from maggots (*abs.*), 14
  Grisovin for horticultural use (*p.r.*), 157
  in the textile industry (*p.r.*), 524
  kanamycin (*p.r.*), 523
  penicillin reactions (*p.r.*), 523
  pharmaceutical processing, 181
  Ristocetin (*p.r.*), 433
  screening with "cancerous" organisms, 135
  staphylococcal resistance to, 523
Anticoagulants (*p.r.*), 252, 434
Anti-dumping order, 83
Antiemetics (*p.r.*), 435
Antifungal agents (*p.r.*), 251
Anti-fungal cream, 265
Antihistamine, non-sedative, 310
Antileprosy drugs, 265, 491
Anti-odorants, 59
Antioxidant in food regulations, 444
Anti-radiation effect of methionine, 95
Anti-seborrhœic agents (*p.r.*), 390
Antispasmodics (*p.r.*), 436
Arsenic in detergents, 363
Aspirin in diabetes (*abs.*), 164
Aspro's new factory, 408
Atherosclerosis treatment (*p.r.*), 250
Atomic energy patents, 535
Australia:
  Drug Houses of Australia, new plant, 239
  drug industry's growth, 401
  imports, 538
  vinyl acetate plant, 538
  W. J. Bush's new factories, 448
Austria, petrochemicals, 401

BACTERICIDAL activity in ampholytic surface-active agents, 52
Bactericides for soap (*p.r.*), 340
Balfour chemical engineering research centre, 259
B.C.P.M.A. annual dinner, 487
"Behaviour of a Commercial Anti-Odorant in Respect of Four Odorous Irritants," by R. W. Moncrieff, 59
Bilharzia in Southern Rhodesia, 88
Biosone skin ointments, 86
Blaw Knox affiliate, 537
Book Reviews:
  "Absorption Spectrophotometry," by G. F. Lothian, 2nd edn., 441
  "Aids to Organic Chemistry," 5th edn., by G. A. Maw, 256
  "'AnalaR' Standards for Laboratory Chemicals," 34
  "Bergey's Manual of Determinative Bacteriology," 7th edn., 165
  "Boiler Feedwater Treatment," by P. Hamer, 279
  "British Pharmacopœia, 1958," 162
  "Characterisation of Organic Compounds," by F. Wild, 2nd edn., 532
  "Chemistry of Organic Medicinal Products," by G. L. Jenkins, *et al.*, 165
  "Comprehensive Inorganic Chemistry," Vol. IV. The Alkali Metals, by J. F. Suttle, 34
  "Cosmetics, Science and Technology, edited by E. Sagarin, 256
  "Dangerous Properties of Industrial Materials," by N. Irving Sax, 211
  "Disinfectants," by W. E. Finch, 301
  "Encyclopædia of Chemical Reactions," compiled by C. A. Jacobson, Vol. 7, 396
  "Encyclopedia of Chemistry Supplement," edited by G. L. Clark, 532
  "Extra Pharmacopœia," Vol. I, 24th edition, 349
  "Handbook of Chemical Data," edited by F. W. Atack, 82
  "Handbook of Chemistry and Physics," by C. D. Hodgman, 82
  "Higher Oxo Alcohols," by L. F. Hatch, 441
  "Induction and Dielectric Heating," 349
  "Industrial Chemicals," by W. L. Faith, *et al.*, 211
  "Industrial and Economic Microbiology in N. America," 315
  "Industry Fights Corrosion," 133
  "Inorganic Syntheses," Vol. V, Ed. T. Moeller, 211
  "Ion Exchange Resins," by R. Kunin, 2nd edn., 396
  "Methods of Analytical Histology and Histochemistry," by Edward Gurr, 532

Book Reviews (*continued*)
"Modern Chemical Processes," Vol. 5, 485
"Naphthalene Compounds," by N. Donaldson, 396
"Neomycin," edited by S. A. Waksman, 485
"Organic Electrode Processes," by M. J. Allen, 301
"Organic Reactions," Vol. 9, edited by Roger Adam, 34
"Organic Syntheses," edited by J. Casson, 485
"Perfumes and their Production," by E. S. Maurer, 441
"Quantitive Organic Analysis," by J. S. Fritz and G. S. Hammond, 121
"Rubber," by Jean Le Bras, 82
"Solvents Extraction in Analytical Chemistry," by G. H. Morrison and H. Freiser, 82
"Source Book of Industrial Solvents," by I. Mellan, 349
"The Terpenes," Vol. V, by J. Simonsen and W. C. J. Ross, 121
Boots Pure Drug Co.:
electronic accountancy, 453
warehouse, new, 471
Boron, uses of, 179
BP Detergents Ltd., 443
B.P. and B.P.C. amendments, 400
Brazil, Bayer factory, 403
British Association's plans for popularising science, 47
British Hydrocarbon Chemicals, plant extension, 487
British-Italian Chemical Congress, 290
British Petroleum Co.'s chemical production, 307
British Pharmaceutical Codex, additions to, 218
British Pharmacopœia, assessment of, 225
Burma, pharmaceutical industry, 89
Bus rides for soap coupons, 272

CATALYSIS, vapour phase, 6
Canadian chemical development, 47, 264
Cancer inhibitors, 173, 221
Capsules, seamless gelatin, 333
Carbide plant in Ulster, 38
Carbon dioxide, inhibiting effect (*p.r.*), 209
Ceylon, chemical factory, 264
Channel Islands patents, 409
Chemical engineering research centre, 259
Chemical engineers employment pattern, 452
Chemical engineers:
post-graduate training, 409
training programme, 134
"Chemical engine," 93
Chemicals in the Free Trade Area, 488
Chemicals or humus? (*p.r.*), 253
Chemical industry, competitiveness, 83
Chemical Market, 44, 90, 130, 173, 222, 263, 312, 358, 404, 449, 494, 540
Chemical output, British, 397
Chemical and Petroleum Engineering Exhibition guide, 240
Chemical plant design:
models, 199
safety, 322
Chemical research, C.R.L. facilities, 304
"Chemical Structure and Odour," 388
"Chemical Wealth from Sugar," by E. T. Dewar, 458
Chemistry diplomas, new scheme, 446
Chemists' Federation, restriction on sale of medicines declared void, 488, 535
Chile, Pfizer's new plant, 89
China:
British chemicals, 40
chemical industry, 401
chemical projects, 309
pharmaceutical industry, 448
Chlorine plant, new, 407
Chloroform controversy, 454
Churchill College, 228
"Ciba's New Production Building at Horsham," 319
"Ciba Pharmaceutical Products' Laboratory," 140
Cold research volunteers, 80
Colours, safety, 3
Company finance:
Albright and Wilson Ltd., 260
Beecham Group, 400, 536
Boots Pure Drug Co. Ltd., 354, 397
British Oil and Cake Mills Ltd., 262
Colgate-Palmolive Co., 262
Distillers Co. Ltd., 354
du Pont, 172
Company finance (*continued*)
Evans Medical Supplies, 259
Fisons Ltd. 536
Glaxo Laboratories Ltd., 262, 490
I.C.I., 443
Monsanto Chemicals Ltd., 167
Smith and Nephew, 490
Thomas Hedley, 490
Timothy Whites and Taylors Ltd., 262
Unilever, 443, 536
Van den Bergh's en Jurgens', 262
Computers and plant design, 500
Computer checks chemical structures, 271
Contraceptive pill, 214
Convulsant drugs (*p.r.*), 250
Corrosion prevention manual, 133
"Corticosteroids from Bile Acids," Uclaf's new factory, 97
"Cosmetic detergent," 310
"Cosmetic Science at German Congress," 469
"Cosmetic Society's Aerosol Symposium," 482
"Cosmetics and Toilet Preparations," by W. W. Myddleton (*p.r.*), 72, 206, 337
Cosmetics:
aerosol formulations, 232
allantoin in creams (*p.r.*), 206
antioxidant (*abs.*), 58
antiperspirant, Na aluminium chlorhydroxy lactate, 171
B.B.C. broadcast, 316
colours, 54
creams, hardness, 469
emulsions, preservation (*p.r.*), 339
formaldehyde preservatives (*p.r.*), 74
hair dyes, 470
infra-red spectroscopy for analysis of creams (*p.r.*), 206
market survey, 272
negro, 49
PEP report, 361
perfumes for:
face creams, 330
lipsticks, 431
poisoning by, 364
polyethylene oxide resins (*p.r.*), 341
powders, sterilisation (*p.r.*), 338
shampoo, 237, 469
sun screen lotion, 237
Vericrest hair conditioner (*abs.*), 115
"Cosmetics, Perfumes for," by V. Vasic
1—Face Powders, 287
2—Face Creams, 330
3—Lipsticks, 431
Cough medicine addiction, 487
Crop protection chemicals in the Sudan, 8
Crop Protection and Pest Control Exhibition, 1, 227
Crop spray problems, 50
Crosfields' new building, 443
Crosfields' new silicate plant at Bow, 36
"Crystal Sieves for Separating Molecular Mixtures," 102
Cumene, phenol from, 2
Customs and Excise Tariff, 1958, 451
"Cyanamid-Lederle Factory Opened," 181

DANGEROUS drugs, control in hospitals, 96
DDT, dispersing wettable, 536
2-Deoxy-D-ribose synthesis, 21
"Designing in 3-D—Models for Plant and Piping Design," by E. Holmes, 370
Detector crayons, 310
Detergents:
arsenic in, 363
bars (*p.r.*), 341
carboxymethyl cellulose (*p.r.*), 343
for cars (*p.r.*), 531
dishwasher, liquid, 237
effects on skin (*p.r.*), 208
Fab, new, 454
flash drying (*p.r.*), 530
foam tests (*p.r.*), 342
Lamol chelating agents, 87
micelles (*p.r.*), 342, 531
nonionics, chemistry and manufacture, 105
packaging (*p.r.*), 530
radioactivity test for efficiency (*p.r.*), 343
rinse additives (*p.r.*), 531
sales (*p.r.*), 340
in sewage, 260
soap and additives (*p.r.*), 529
soap production in Europe (*p.r.*), 530
sugar-derived, 152
tallow (*p.r.*), 529
Detergents (*continued*)
in toothpastes (*p.r.*), 337
ultrasonic cleaning, 493
"Detergents and Detergency," by Leon Raphael (*p.r.*), 340, 529
Detergents and sewage foam, committee report, 84
Diazo centenary, 49
Disinfection:
azotobacter, sonic disruption (*p.r.*), 481
caprylate in sterility testing (*p.r.*), 480
Disinfectants:
hard water activity (*p.r.*), 75
Liesegang rings in tests (*p.r.*), 76
Properdin and burn infection (*p.r.*), 75
sanitiser, 238
sea water bactericide (*p.r.*), 75
"Disinfectants and Disinfection," by A. H. Walters (*p.r.*), 75, 209, 389, 479
Distillation, molecular, 240
Diuretic, oral, 539
Diuretic *Saluric*, 87
Diuretics (*p.r.*), 154
"Dollar Technology in Britain," 365
"Dollar Technology in Britain," (*l.*), 539
Dominican Republic, pharmaceutical industry, 88
Drug addiction, 363
"Drug Houses of Australia Link-up with American Cyanamid," 239
Drug trials, finance of, 451
Drugs, approved names, 263, 446
Dry cleaning bath, 237
"Drying Plant and Equipment for a Variety of Tasks," 462
D.S.I.R. reorganisation, 227, 499
Duncan Flockhart laboratory, 535
Dyed grass, 486
Dyes, Procion Rubine B, 493
Dynamite manufacture, 291, 293

E. coli, effect of heat or chlorine (*p.r.*), 210
EDTA and streptococcal infection (*p.r.*), 209
Effluents, radioactive, 95
"Electronic Computation of Stresses in Pipe Systems," by C. F. Gradwell, 374
Electronic reading and computation at Boots, 453
Encapsulation of powders, 183
Engineers, training, 1
Ergot, film story, 104
Essential oils:
aldehydes and ketones, spectrophotometric assay (*p.r.*), 476
Anemopsis California, methyl eugenol from (*p.r.*), 30
black pepper, composition of volatile oil (*p.r.*), 30
Brazil's bois de rose industry (*p.r.*), 31
cineole in lavender oil (*p.r.*), 476
citrus, U.V. check on (*p.r.*), 28
Indian hemp (*abs.*), 82
lemon, coumarins in, 29
mint, variations in oils (*p.r.*), 477
molecular refraction (*p.r.*), 478
piperitenone and diosphenolene (*p.r.*), 477
South African industry, 127
See also *Perfumery*
Ethicon's new building, 350
Ethylene oxide condensation products in soap, 233
European chemical production, 488
European Free Market, impact on packaging and handling, 204
Evans Medical's Liberian venture, 83
Evans Medical (Midlands) Ltd., 537
"Exceeding Small," 505
Expanded polystyrene plant, 443

FARMITALIA factories, 293
Fatty acids in soap (*p.r.*), 340
Fatty alcohols for water conservation, 352
"Feedwater Treatment, Boiler," by P. Hamer, 279
Fertiliser Society anniversary, 135
Fertilisers:
boron (*p.r.*), 393
caking problems (*p.r.*), 116
concentrated complete fertiliser plant, 109
farm practice (*p.r.*), 253
granule caking (*p.r.*), 392
irrigation (*p.r.*), 252
Kay Nitro, 493
liming (*p.r.*), 392
magnesium in plant nutrition (*p.r.*), 117
manufacture (*p.r.*), 253
nitrophosphates (*p.r.*), 392

Fertilisers (*continued*)
phosphate tests (*p.r.*), 117
prospects, 178
steam granulation (*p.r.*), 116
sulphur (*p.r.*), 393
superphosphate manufacture (*p.r.*), 117
theory of (*p.r.*), 254
ureaforms (*p.r.*), 392
use survey (*p.r.*), 391
"Fertilisers and Plant Nutrients," by D. P. Hopkins (*p.r.*), 116, 252, 391
Film base plant, Bexford Ltd., 353
Fire precautions:
Fireball extinguisher, 328
fire-resisting doors, 328
pressure-charge-operated extinguishers, 327
Fisons-Murphy agreement, 444
"Flow Measurement in the Chemical Industry," 9
Flow measurement:
bell-type meter, 13
bellows, 12
Dall tube, 10
differential pressure meters, 10
electrical transmitters, 13
electro-magnetic meters, 14
integrators, 13
mercury manometer, 12
pitot tube, 11
pneumatic transmitter, 12
ring balance meter, 13
ultrasonic meters, 14
variable area meters, 13
venturi tube, 10
Fluid grinding for insecticidal dusts (*p.r.*), 157
Fluoridation of water, 50
Fluoride dentifrices, 318
Fluorine in foods, 40
Foam inhibitors, silicone, 493
Foaming characteristics of nonionics, 108
Formaldehyde, reaction with animal glue and gelatine, 103
Formica decorative laminates, 145
France:
new Reichold factory, 538
Stalinon case, 43
Free trade area, chemical in, 488
Fumigants (*p.r.*), 438
Fungicides:
antibiotics (*p.r.*), 437
Captan, 33
copper (*p.r.*), 32
mercury, 449
organo-tin (*p.r.*), 437
Pipone (*p.r.*), 389
8-quinolinol (*p.r.*), 295
sugar inhibitors (*p.r.*), 481
trichloromethyl thio-sulphonates (*p.r.*), 32
Fungistats (*p.r.*), 480

"GAS Chromatography, Recent Developments," by R. P. W. Scott, 411, 517
"Gas-liquid Chromatography," 203
Gelatine, treatment with formaldehyde, 103
Genatosan, pharmaceutical development, 455
Genatosan's £65,000 extensions, 40
Germany:
chemical industry's performance, 219
cosmetics congress, 469
"Germicidal Ampholytic Surface-Active Agents," by Dr.-Ing Adolf Schmitz and W. Sim Harris, 51
"Germicides Based on Surface-Active Agents," by C. D. Moore and R. B. Hardwick, 194
Gibberellic acid, 168 (*p.r.*), 254, 265
Glaucoma, acetazolamide for (*p.r.*), 434
Glaxo extension, 537
Glaxo-Allenbury merger, 179
Glue, treatment with formaldehyde, 103
Glycerin, improved, 403
Glycerin and violin strings, 80
Goodyear chemical manufacture, 443
Gum tragacanth preservatives (*p.r.*), 479
Gums, emulsifying properties (*p.r.*), 337
Gypsum, production and uses, 409

H-BOMB mishap in South Carolina, 166
Health expenditure and revenue, 486
Help for small firms, 317
Heparin (*p.r.*), 436
Hinchliffe Committee report, 269
Holland:
Anglo-Dutch Trade Council, 448
chemical industry turnover, 492
Holland (*continued*)
soda ash plant, 89
synthetic glycerin plant, 309
"Hormones," by C. A. Finch, (*p.r.*) 113
Hormones:
biosynthesis of the cholesterol system, 113
corticosteroids from bile acids, 97
corticosteroids, Ledercort, 265
corticosteroids (*p.r.*), 155
cortisones, manufacture, 97
oestrogens (*p.r.*), 435
steroid formulations, new, 356
Hydrogen peroxide, Laporte plant, 500
Hypoglycæmic, oral, *Diabinese*, 493
Hypertension drugs (*p.r.*), 154
Hypotensive drugs (*p.r.*), 433

I.C.I.:
expenditure on chemical plant, 215
Ilford link-up, 397
"Ilford's Organic Chemical Laboratories," 137
Ilford's Photographic Film Research Laboratory at Brentwood, 25
Import rationalisation, 451
India:
streptomycin plant, 533
first explosives factory, 538
Indigestion powders—misleading advice (*l.*), 198
Insect repellents and attractants (*p.r.*), 33
Insecticides:
chlorbenside (*p.r.*), 157
chrysanthemumic acid, 134
immunity to, 362
Kil, 265
milk residues (*p.r.*), 156
organotin compounds, 305
parathion toxicity (*p.r.*), 156
Phosdrin, 87, (*p.r.*), 157
phosphorus (*p.r.*), 297
pyrethrum synergists (*p.r.*), 156
residues (*p.r.*), 295
Sevin (*p.r.*), 156
sulphides, organic (*p.r.*), 295
"Instrumentation in a Small Fine Chemical Works," by D. E. B. Greensmith, 5
Instrumentation of batch nitration process, 5
Instruments and Apparatus:
automatic analysis, 15
bell-type meter, 13
bunsen burner, *Jet Maximus*, 148
calorimeter, isothermal bomb, 244
cleaning, ultrasonic, 20
chromatograph, argon, 344
chromatograph, gas, 15, 16, 224, 394
chromatography, partition, 303
countercurrent extraction, 15
Dall tube, 10
deioniser, water, 244
developments and trends in, 9, 15
diagrammatic panels, 8
differential pressure devices, 10
ebulliometer, semimicro, 149
electrical flow transmitters, 13
electrometer, gamma-ray, 440
flow meters, 9, 13, 14
hygrometer, 19, 149
infra-red accessories, 149
integrators, 13
level controller, 81
melting point apparatus, 534
moisture tester, vacuum, 17
operation recorder, 18
*p*H meter, 17
photometer, recording amino acid, 395
pneumatic flow transmitter, 12
polarimeter, 150
polarograph, 149
portable instruments, 8
process control installation, 17
radioactive tracer equipment, 20
reading instruments, 12
recording and control apparatus, 16
recording ribbons, coloured, 20
ring balance meter, 13
smoke density meters, 212
spectrometer, wavelength, 484
spectrophotometer, SP. 900 flame, 150
spectrophotometry accessories, 19
steam raising, 7
sulphur content determination, 20
temperature controller, 17
temperature recorder, 8
titration, potientometric, 19, 150
Instruments and apparatus (*continued*)
titrator, automatic, 150
turbidity meter, 118
Uvispek prism, 81
venturi tube, 10
X-ray spectrometer, 164
Insulin, zinc methyl-albumin (*l.*), 115
Insurance, industrial injuries, 351
Interferon and virus disease, 364
Inventa processes for methanol and formaldehyde production, 63
Inventions, N.R.D.C., 133
Irradiation sickness (*p.r.*), 251
Isceon fluorocarbons, 104
Israel, potash pipeline, 43
Italian-British Chemical Congress, 270, 290
Italian chemical industry, Anglo-Italian opportunities, 270
Italian Chemical Society Congress, 290

JAPAN, petrochemicals and plastics, 401
Jordan, potash plant, 126
Jurel multivitamin tablet, 539

KESTNER jubilee, 318
K.I.D. additions and exemptions, 170, 262, 304, 398, 444, 490
K.I.D., polymers case, 535
Kojic acid (*p.r.*), 250
Korea, talc plant, 309

LABELLING of hazardous chemicals, 180
Laboratory chemicals, supply of, 153
Laboratory design, 137, 140, 142
"Laboratory Furnishing and Equipment," 137
Laboratory furniture, 144
Lederle Laboratories' new factory, 167
Living cells, chemistry of, 136
Luminous roads, 166

"MECHANICAL Aids to Productivity," 257
Mechano-chemical system, 93
Medical gas pipeline, 535
Metallic ions and streptococcal infection (*p.r.*), 209
"Methanol and Formaldehyde Production," 63
Methocarbamol (*p.r.*), 434
Metric system, 442
Mexico:
chemical output, 448
sulphur production, 264
Microbiology, industrial, 315, 499
Miticides, *Phostex* (*p.r.*), 32
Mixing:
gas absorption in agitated reactors, 185
heat transfer in mixing operations, 185
liquids, blending of, 184
powders, 187
"Mixing and Blending," by D. F. Riley, 184
Models for plant design, 370
Moniliasis treatment (*p.r.*), 434
Montecatini factories, Avigliana, Italy, 292
Moth proofer, 310
Mydriatics (*p.r.*), 251

NATIONAL chemical centre, a (*l.*), 384
National Chemical Laboratory (formerly C.R.L.), 350, 499
National Health Service:
"concealed" profits of chemists, 397
pharmaceutical costs, 38, 123, 177, 217, 269, 397
prescribing changes after ten years, 487
National Research Development Corporation Report, 133
New companies, 46, 92, 129, 175, 220, 267, 311, 357, 403, 449, 496, 542
New patents, 46, 91, 128, 176, 224, 267, 314, 360, 406, 450, 498, 542
New trade marks, 46, 92, 127, 175, 224, 268, 314, 357, 406, 450, 497, 542
New Zealand, chemical import licensing, 126
Nitrofuran manufacture, 230
"Nitrofurans and Pharmaceuticals," 229
Nitrogen, industrial uses, 4
Nobel Prize for chemistry, 487
Noise abatement in industry, 4
"Nonionic Surface-active Agents," By Leon Raphael, 105, 237
Nor-adrenaline (*p.r.*), 251
Nuclear magnetic resonance, 2

ODORANT counteracting, 59
" Odour, Chemical Structure and," 388, (*l.*), 427
Olfaction, anti-odorant performance, 59
" Organic Peroxides and Their Uses," 348
" Organo-metallic Compounds,"
by Leon Raphael, 346
Otosporin drops for ear infections, 86

PACKAGING:
aerosol containers, 66, 96
aerosols, fitness for purpose, 226
aerosol stencilling, 266
aerosol vials, ½ oz., 221
ampoules, 70
" Armadillo " container, 311
caps, wadless for tubes, 71
carboy pack, 491
carboys, thin-wall polythene, 447
ceramic labelling, 174
closures, plastic screw, 71
collapsible containers, 70
coating, strippable, 447
containers, anti-corrosive, 68
Cubitainer, 491
dispensing unit for bottles, 539
fibreboard cases, 70
gum dispensers, 66
Hypak, 70
impregnated cloths, 447
isotopes for checking (*p.r.*), 72
labels, permanent, 447
labels, self-adhesive, 69
Metathene film, 69
name plates, adhesive, 266
pencil for glazed surfaces, 447
Netlon plastic net, 491
Pliofilm laminated film, 69
polythene film, 70
polythene " jerricans," 174
polythene-lined pockets, 69, 539
polythene squeeze bottles (*p.r.*), 206
puffer pack for powder, 539
sacks, multi-wall paper, 69
sealer, gummed paper, 447
sealing polythene and paper, 491
seals, viscose, 70
self-adhesive tape, 69
steel strapping machine, 68
strapping tape, 491
tape dispenser, 66
tape, double-sided mounting, 447
transparent tape, coloured, 71
tubes, long nozzle, 68
vial and ampoule printer, 67
visible packaging, 539
" Packaging and Distribution,"
by R. E. Rushen, 204
" Packaging and Handling,"
by Geo. Downie, 204
" Packaging, Handling, Transport," 204
Paper, stretchable, 94
Parkinsonism, drugs for (*p.r.*), 433
Patents, report of Comptroller-General, 362
Pemphigus, control of (*p.r.*), 210
Penicillamine treatment for metal poisoning, 86
" Perfumes for Cosmetics,"
by V. Vasic
1—Face Powders, 287
2—Face Creams, 330
3—Lipsticks, 431
Perfumes:
antibacterial, 452
cyclopentanone, 493
dendrolasin in ants (*p.r.*), 29
Dragoco specialities, 87
geraniol, synthetic, 86
linalol, synthetic (*p.r.*), 31
pharmacology, 469
spray-dried (*p.r.*), 342
See also *Essential Oils*.
" Perfumery and Essential Oils,"
by G. B. Pickering (*p.r.*), 28, 476
Permanent pleats in wool, 317
" Peroxides, Organic, and Their Uses," 348
Pessaries, anti-fungal, 355
" Pest Control Chemicals,"
by D. P. Hopkins (*p.r.*), 32, 156, 295, 437
Pesticides:
citrus red mite control (*p.r.*), 33
crop spray hazards, 50
development costs of new chemical (*p.r.*), 437
lacquer, insecticidal, 449
Leonard Hill exhibition, 1
Pesticides (*continued*)
locust control (*p.r.*), 438
mercury *versus* potato eelworm (*p.r.*), 33
M.G.K. Repellent 11, 87
miticide, *Nialate* (*p.r.*), 32
steriliser, soil, 449
wetting agents for sprays, 385
Pest Infestation Laboratory report (*p.r.*), 438
Pest infestation research, 362
Petroleum chemicals, 307
Pfizer buy Kemball Bishop, 488
" Pharmaceutical Development, the Link Between Research and Production,"
by N. J. Van Abbe, 455
" Pharmaceutical Development at Loughborough," 456
" Pharmaceutical Industry, Water for,"
by A. H. Waddington, 275
Pharmaceutical production methods—WHO rules, 270
Pharmaceuticals:
future trends, 226
thiazoles in synthesis of, 111
Pharmacy and Poisons Act changes, 535
Phenol from cumene, 2
Phosphorylation, 291
Photographic film research laboratories, 25
" Pipe Systems, Electronic Computation of Stresses,"
by C. F. Gradwell, 374
" Piping and Plant Design—Can Linear Programming Help?"
by A. Battersby, 368
Pipes and pipework:
cleaning processes, 380
epoxy resin lined, 379
fabrication and erection, 376
glassed steel and glass, 377
heating by electrical tapes, 380
high impact pvc pipe fittings, 531
plastic hose, 379
stainless steel fittings for, 379
stoneware, 378
tapes, protective, 380
titanium, 378
tubes, bi-metal, 378
vacuum systems, 376
" Pipework for the Chemical Industry," 376
Piperoxane (*p.r.*), 251
Plant deliveries, criticism of, 487
Plant and Equipment:
aerosol equipment, 67
attrition grinder, *Bauermeister*, 509
Atritor dryer-pulveriser, 509
Attritor, Torrance, 509
autoclave, glassed steel, 240
ball mill, porcelain, 302
bursting discs, 247
bursting discs, graphite, 119
carton overprinters, 65
carton sealer, automatic, 533
centrifuge, variable speed, 242
ceramics, corrosion-resistant, 244
ceramics, porous, 243
checkweighers, electronic, 64
compound ball tubemill, 512
compressed air plant, 243
cooling towers, 245
crystalliser, 247
crystallisers, high vacuum, 212
data handling system, 484
demineraliser, portable, 151
dental cartridge machine, 394
disc grinder, 510
dispersitron, 240
distillation column, benzole, 240
distillation plant, 242, 244
drum storage units, 311
dryers:
blender-dryer, 240, 468
conveyor, 467
film, 465
fluid bed, 240
freeze, 464
hot air equipment, 468
industrial, 246
inert gas, 466
laboratory spray, 246
pneumatic ring, 465
pulveriser, 245
oven, 302
rotary, 465
silica gel, 468
spray, 240, 462
" Turbo " tray, 466
vacuum, 463
Plant and Equipment (*continued*)
dust collector, 163
electrical system, air-pressurised, 244
evaporator:
plate, 240
climbing film, 246
fan, extractor, 244
fans, moulded pvc, 35
filling, vacuum, 65
filter presses, plate and frame, 35
filter, rotary vacuum, 243
filtration, small-scale, 242
fire detection, automatic, 212
fire extinguishers, 243
fire protection equipment, 247
furnaces, electric, 145
gas washer, 246
glassware, laboratory, 147
glassware washer, 147
glove cabinets, 147
graphite, corrosion-resistant, 241
grinder, vibro-energy, 345
grinding, high frequency, 241
grinding mills, fluid, 302
gum conditioning and dispensing, 483
heat exchangers, 240, 245, 247
heat generator, 245
heater, forced circulation, 240
heater for semi-micro chemistry, 483
heater, surface, 245
Hypalon hose, 120
incinerator, automatic, 35
incubator, 148
kettles, isoductive heated, 246
labelling machine, 66, 439
level controller, 344
lifting and discharging, 483
liquid dosing, 345
mechanical handling, 257
metal detectors, 68
mills:
ball, 508
ball, laboratory, 148
colloid, 510
comminuting, 510
disc and peg, 507
hammer, laboratory, 148
pin disc, 510
pulverising, 512
roller, 508
swing hammer, 507
" Tornado," 510
Vibro Energy, 509
mixers:
blenders, 193
continuous, 247
double cone, 191, 244
double worm, 192
functional design, 184
laboratory, 188
liquid, 246
mixer/pasteuriser, 188
multi-purpose, 191
paddle type, 188
powder blending, 484
Rotocube dry powder, 189
stirrers, 193
turbo-cleaver, 119
turbo impeller, 192
uni-rotor, 190
vertical, large, 190
vibratory, 255
mixing of warm water, thermostatic, 148
nitrate plant, laboratory, 246
nitrogen plant, 241
ovens, 146, 467
overprinter, 303
oxygen plant, 241
packaging and bottling machines, 344
plastic tower for plant, 345
platinum, 246
pouch forming machine, 65
pressure vessel, vacuum, 244
printer (screen) for containers, 164
printing machine, bottle, 213
programme controller for cosmetics manufacture, 163
pumps:
acid, 246
Archimedean, 118
chemical, 241
corrosive liquid, 246
glassed, 240
powder, 247
rotary displacement, 243
reactor, enamelled, 242

Plant and Equipment (*continued*)
seal, mechanical, 243
sieve, test, 148
soap presses, pneumatic, 439
still for inflammable solvents, 533
stoppering under vacuum, 303
strip packaging machine, 534
tablet de-dusting, 394
tableting and compression coating, 246
tanks, flexible, 533
tanks, "tailor-made," 164
Tickopres machine, 65
timer, auto-reset, 118
titanium metal plant, 245, 271
Tote handling of powders, 440
tower packings, 245
valves:
automatic, 246
diaphragm, 35, 246
gate, 245
gate type, high vacuum, 213
taper plug, 240
Vapormatic motor starter, 120
water baths, stainless steel, 394
water deioniser, laboratory, 151
water stills, 81
water treatment, 275
work table, 484
wrapping, automatic, 65
"Plant Protection's New Laboratories," 142
Plastics, toxicity, 94, of PTFE, 262
"Poeierkwashlom" extract for heart disease, 88
Poisoning, industrial, 48
Polishes, silver, 237
Potato sprout depressant, 403
Preservatives inactivation (*p.r.*), 390
Prices (Bromborough) Ltd., safety procedure, 324
Promazine (*p.r.*), 249
Propylene oxide for sterilising powders (*p.r.*), 348
Protective clothing:
fire-proof suits, 329
plastic suit, 439
PVC clothing and gloves, 328, 329
respirators, 329
Psychomimetic drugs (*p.r.*), 436
Purchase tax, 258
Purchase tax exempted drugs, 167, 445
Pyridine-2-aldoxime methiodide (*p.r.*), 435

QUATERNARY ammonium compounds, 196, 197, 198
QVF-Pyrex merger, 400

RADIOACTIVE:
labelling methods, 57
pharmaceuticals, 58
pharmacological study, 316
wastes, 94
Radiation, sterilising syringes by, 479
"Radiochemical Centre Enlarged," 55
Radio-isotopes, Radiochemical Centre, 55
Rauwolfia and other hypotensives (*p.r.*), 154
Relaxants (*p.r.*), 250
Rodenticides, fluoroacetamide (*p.r.*), 158
Roumania, chemical output, 410
Royal jelly, 80, 88
Rubber antioxidant, *Santovar A*, 87
Rubber, synthetic, Monstanto's *Tred* plant, 39
Russian salaries, 122

"SAFE Operation of Chemical Plants," by E. W. Jackson, 323
"Safe Practice is a Basic Factor in Manufacture," by Sir William Garrett, 322
Safeguarding of Industries Act, repeal, 352
Safety:
electrical, 326
flame failure monitor, 328
hydrogen sulphide detectors, 326
Isomantles, 326
mercury vapour meter, 327
Safety in chemical industry, 408
Safety colours for use in industry, 3
"Safety Equipment and Protective Clothing," 326
Sandoz' new factories, 217
Science and the boardroom, 361
"Science and Business, Partnership of"—Sir Alexander Fleck's Presidential address to British Association, 361, 382
Science, case for Minister of, 225
Science in novels, 136
"Scotland's New 3 million Fertiliser Works," 109
"Seamless Gelatin Capsules," 333
Secrecy, technological, 269
Sedatives (*p.r.*), 249
Seed disinfection (*p.r.*), 296
Shampoo, colourising, 539
Sieves, crystal, 102
Silanes, uses of, 393
Silicates, Crosfields' new plant, 36
"Size Reduction Machinery," 509
Skin fats, absorption, 469
Slimming claims, 490
Smith, Kline and French factory description, 229
Snake venom, composition, 453
Soap in antiquity (*p.r.*), 340
Soaps and detergents, effects on skin (*p.r.*), 208
"Soap, Improvement with Ethylene Oxide Condensation Products," by Dr. H. E. Tschakert, 233
Sodium hazard in bottles, 80
Solvents and antibacterial organic acids (*p.r.*), 389
Souberein, Eugene, 454
South Africa:
Allenburys' laboratories, 402
essential oil industry planned, 126
nitrogen plant, 264
S.A. Druggists acquisition, 448
Squibb's centenary, 317
Sterilisation of cosmetic powders (*p.r.*), 338
Sterilisation of dressings, steam (*p.r.*), 390
Steroids:
from bile acids, 97
spot tests for (*p.r.*), 73
Streptococcal infection, metallic ions, EDTA and (*p.r.*), 209
Sucrose, chemicals from, 458
"Sugar, Chemical Wealth from," by E. T. Dewar, 458
"Sugar Detergents," by H. B. Hass, 152
Sugar esters, properties of, 153
Sulphur prices and supplies, 177
Suntan pill, 310
Suntan tablets, 407
Surface-active agents:
alkylolamides, 194
amine oxides, 194
ampholytic, 52, 195
amphoteric, 265
betaines, 195
cationic, for cosmetics (*p.r.*), 74
long chain N substituted amino acids, 195
non-ionics, 194
revised list (*p.r.*), 207
separation of non-ionics from mixtures containing anionics (*p.r.*), 72
sugar esters, 195
and phenols, behaviour of, 197
and q.a. compounds, behaviour of, 196
"Synthesis and Application of Acyl Halides"—1, 428, —2, 473, by Greville Machell
"Synthesis of 2-deoxy-D-ribose," by Greville Machell, 21
Syringe infection (*p.r.*), 479

TABLET manufacture at Cyanamid-Lederle, 182
"Technical Packaging Problems," by G. L. Riddell, 205
Tetrahydrothiophene, 86
"Therapeutics," by S. J. Hopkins (*p.r.*), 154, 249, 433
Thermonuclear parity?, 122
Thermonuclear power, 48
"Thiazoles and Analogues—some Pharmacological Applications," by E. G. Curphey, 111
Thiazoles as psychiatry aids, 111
Tic Douloureux (*p.r.*), 156
Titanium chemical plant, 271
Tolpronine (*p.r.*), 249
Toothpastes, detergents for, 337
Tranquillisers in animal food, 180
"Treatment of Glue and Gelatine with Formaldehyde," by A. M. Kragh, 103
Tropical Products Institute, new building, 1

UCLAF, new corticosteroid factory, 97
U.S.A.:
antibiotic monopoly charge, 302
chemical industry expansion, 94
Colgate's biological laboratory, 492
Croda developments, 538
Du Pont's expansion, 172
Histidine available, 538
Stauffer Pharmaceuticals Inc., 538
pituitary growth hormone, 538

VASODILATOR, 310
"Veterinary Antibiotic Preparations," by G. N. Henderson and C. F. Abbott, 513
"Veterinary Antibiotics," current, 515
Veterinary drugs:
Frantin, 355
Hepzide, 355
Imposil, 355
Ultracortenol, 493
"Victorian Drug Industry," by Hugh Lattimer, 132
"Vision" drug, 492
"Vitamin Moisture Balancer," 539
Vitamin D, acyl halide intermediate, 474
Vitamins, multi-vitamin product, 449

WAREHOUSING, Boot's techniques, 471
Warfarin (anticoagulants) (*p.r.*), 252
"Water Conservation and Purification," 273
"Water for the Pharmaceutical Industry," by A. H. Waddington, 275
Water pipes, freeze repair, 255
Water treatment:
chelating agents, 286
chlorinators and associated instrumentation, 285
chlorinators, 286
clarification, purification and deionisation, 283
decarbonation plant, 285
deionisation and filtration, 283
deionising resins, regeneration of, 284
demineralising plant, 283
ionomatic, 283
lime-free water, 289
scale inhibition, 289
stills, automatic, 284
ultra-violet sterilisation, 284
"Water Treatment Plant and Services," 283
Weedkillers:
1 : 1′-ethylene-2 : 2′-dipyridylium dibromide, 96
1 : 1′-Ethylene-2 : 2′-dipyridylium (*p.r.*), 157
Fisons 18-15, 171
grass killer, *Dowpon*, 403
selective (*p.r.*), 296
warning on usage, 304
Wellcome Museum of Medical Science, 228
"Wetting Agents for Agricultural Sprays," by J. S. Stanley, 334, 385
Whitening agents, fluorescent, 442
Windscale fire, 166
"Work Study Helps in the Design of Chemical Plants," by E. H. Salisbury, 199
Work study in small firms, 226
World Health Organisation anniversary, 178
"Wyeth's New Research Laboratories," 503

ZETA, 48

AUTHOR INDEX

Abbott, C. F.:
"Veterinary Antibiotic Preparations," 513

Battersby, A.:
"Piping and Plant Design—Can Linear Programming Help?" 368

Dewar, E. T.:
"Chemical Wealth from Sugar," 458
Dickenson, D. R.:
"Air Conditioning Requirements of the Pharmaceutical Industry," 417
Downie, Geo.:
"Packaging and Handling," 204

Fleck, Sir Alexander:
"The Partnership of Science and Business" (*abs.*), 382
Finch, C. A.:
Hormones (*p.r.*), 113

Garrett, Sir William:
"Safe Practice is a Basic Factor in Manufacture," 322
Gradwell, C. F.:
"Electronic Computation of Stresses in Pipe Systems," 374

Hackett, D.:
"The Selection of Air Conditioning Plant," 420
Hamer, P.:
"Boiler Feedwater Treatment," 279
Hardwick, R. B.:
"Germicides Based on Surface-Active Agents," 194
Harris, W. S.:
"Germicidal Ampholytic Surface-Active Agents," 51
Hass, H. B.:
"The Sugar Detergents," 152
Henderson, G. N.:
"Veterinary Antibiotic Preparations," 513
Holmes, E.:
"Designing in 3-D—Models for Plant and Piping Design," 370
Hopkins, D. P.:
"Fertilisers and Plant Nutrients" (*p.r.*), 252, 391
"Pest Control Chemicals" (*p.r.*), 32, 156, 295, 437
Hopkins, S. J.:
"The New B.P.—A Book of Contrasts," 162
"Therapeutics" (*p.r.*), 154, 249, 433

Jackson, E. W.:
"Planning for Safe Operation of Chemical Plants," 323

Kragh, A. M.:
"Treatment of Glue and Gelatine with Formaldehyde," 103

Lattimer, H.:
"Victorian Drug Industry," 132
Levin, R.:
"Antibiotics" (*p.r.*), 523

Machell, Greville:
"The Synthesis of 2-deoxy-D-ribose," 21
"Synthesis and Applications of Acyl Halides," 428, 473
Moncrieff, R. W.:
"Behaviour of a Commercial Anti-Odorant," 59
Moore, C. D. and Hardwick, R. B.:
"Germicides Based on Surface-Active Agents," 194
Myddleton, W. W.:
Progress Reports:
"Cosmetics and Toilet Preparations," 72, 206, 337

Pickering, G. B.:
Progress Reports:
"Perfumery and Essential Oils," 28, 476

Raphael, Leon:
"Detergents and Detergency" (*p.r.*), 340, 529
"Nonionic Surface-Active Agents," 105, 237
"Organo-Metallic Compounds," 346
Riddell, G. L.:
"Technical Packaging Problems," 205
Riley, D. F.:
"Mixing and Blending," 184
Rushen, R. E.:
"Packaging and Distribution," 204

Salisbury, E. H.:
"How Work Study Helps in the Design of Chemical Plants," 199
Schmitz, A.:
"Germicidal Ampholytic Surface-Active Agents," 51
Scott, R. P. W.:
"Recent Developments in Gas Chromatography," 411, 517
Stanley, J. S.:
"Wetting Agents for Agricultural Sprays," 334, 385
Stephen, William I.:
Progress Reports:
"Analytical Chemistry," 77, 158, 297, 526

Tschakert, Dr. Hans E.:
"Improvement of Soap with Ethylene Oxide Condensation Products," 233

Van Abbe, N. J.:
"Pharmaceutical Development, the Link Between Research and Production," 455

Vasic, V.:
"Perfumes for Cosmetics:
1—Face Powders," 287
2—"Face Creams, 330
3—"Lipsticks," 431

Waddington, A. H.:
"Water for the Pharmaceutical Industry," 275
Walters, A. H.:
Progress Report:
"Disinfectants and Disinfection," 75, 209, 479

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The Micronizer

for grinding to micron sizes

Flexible: It grinds dry solids to sub-sieve sizes and the lower micron ranges. It handles small quantities of valuable materials or large tonnages of commercial products.

Versatile: It handles with equal success materials that are heat-sensitive or very hard substances.

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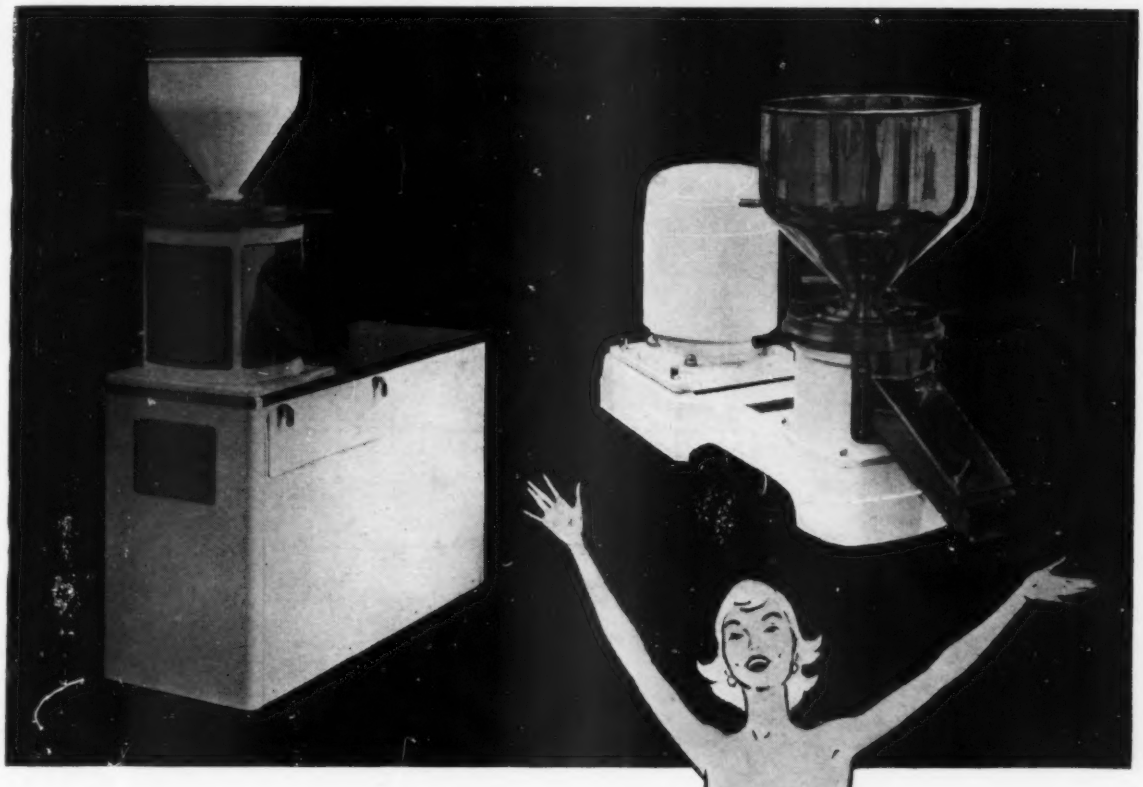

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If your processes involve dispersion, fine grinding or emulsification, then you should investigate these two new Premier mills: these newcomers, from P.C.M., the 3" Mark II and the larger 6" Production Unit give results hitherto unobtainable. The advanced design of these machines gives a simplicity of operation and handling economy not to be found in any other mill today. No other machines can be so easily adjusted, no other machine can be so easily cleaned.

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G-11 is available in powdered, liquid or bar soaps, and in detergents and waterless hand cleaners. All G-11 soaps must meet rigid specifications for G-11 content. Hexachlorophene liquid soaps are the only antiseptic soaps recognized by the United States Pharmacopoeia and *must* be produced to stipulated specifications.

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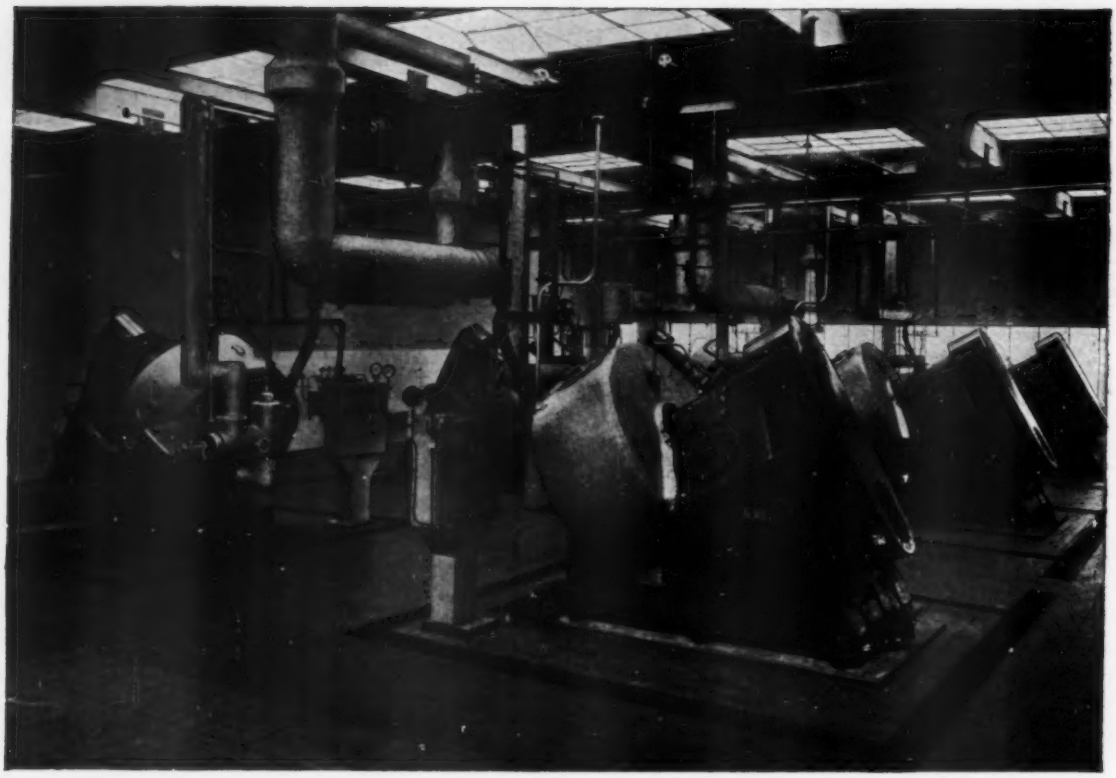

Successful chemical processing is not an accident—it results from patient and carefully planned research and calls for exceptionally skilled manufacturing techniques.

BROADBENT CENTRIFUGALS are called in to perform many difficult duties in modern chemical processing and it is significant that the problem of producing paraxylene, one of the basic constituents of "TERYLENE," is entrusted to them at the famous Wilton Works of Imperial Chemical Industries.

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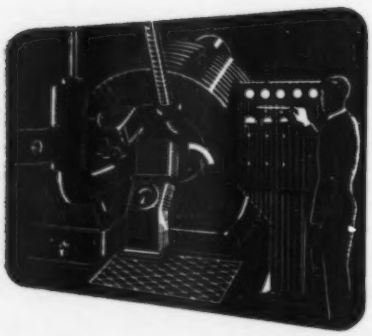

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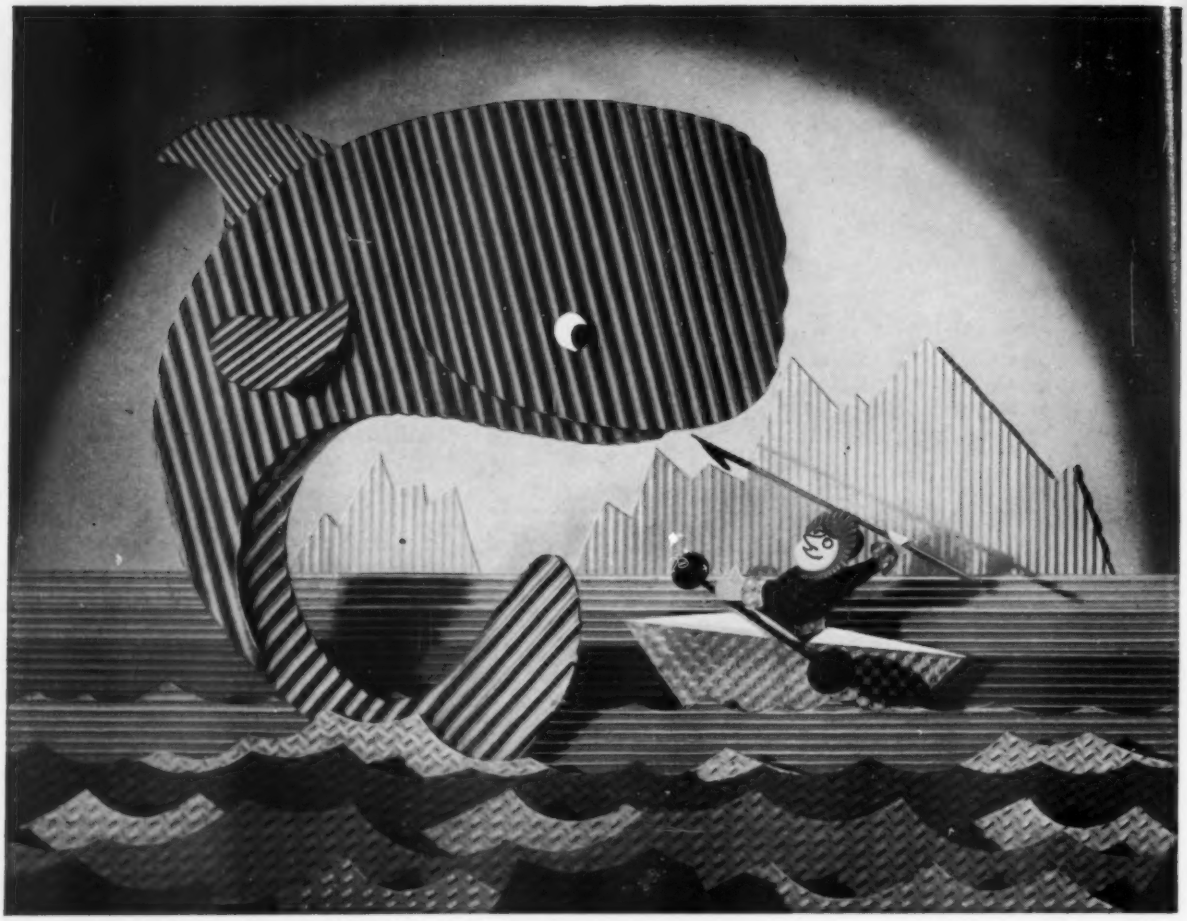

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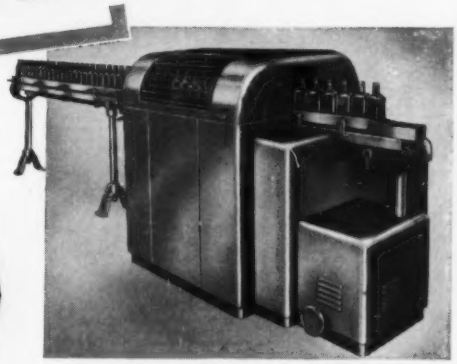


AUTOMATIC AIR CLEANER

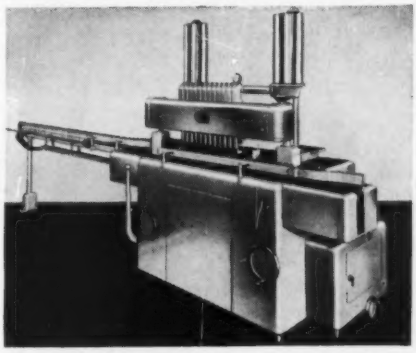
Fully automatic air cleaning of bottles, jars or jugs 3 to 32 oz.

CAPACITY: up to 120 per minute.

LOADING: manual or conveyor.

Variable speed approach reduces risk of breakage.

Dust exhaust equipment can be supplied as an optional extra.



SAMCO AUTOMATIC VACUUM FILLER *(Straight Line)*

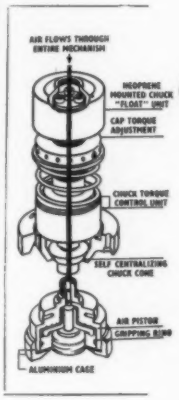
Fully automatic uniform filling of liquids and semi-liquids.

CONTAINERS: Bottles, cans, jars (regular or sprinkler top bottles).

CAPACITY: 1 oz. to 1 quart.

SPEED: 12 filling head unit rated 70 open mouth pints per minute on free flowing liquids.

Note: *Can be fitted with extra heads and increased capacity filling.*



PNEUMACAP—FOUR CAPPER

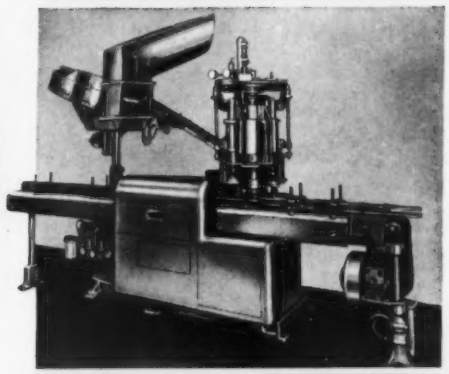
Greatest Advance in Sensitivity, Flexibility, positive action and controlled torque.

Simple positive non-slipping grip for all types of pre-threaded closures. Particularly efficient for fragile moulded closures.

The Pneumacap is available in 4, 6 or 8 head models, each completely automatic and operating with exclusive design air chuck (see opposite). Helical Feed Intake. Individual, synchro or line shaft drive as desired.

SPEED: 120 per minute.

CAPACITY: Max. container dia. 4″.
Max. cap size 89 m/m.



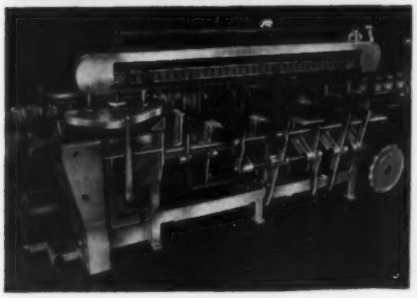
5″ AUTOMATIC DUPLEX PRECISION LABELLER

Ideal for volume requirements of wide variety of containers.

CAPACITY: Handles *containers* less than 4″ wide and *labels* less than 4¼″ wide.

Round, oval or rectangular containers run with either front only or both front and back labels applied simultaneously.

SPEED: Rated 80-120 per minute.



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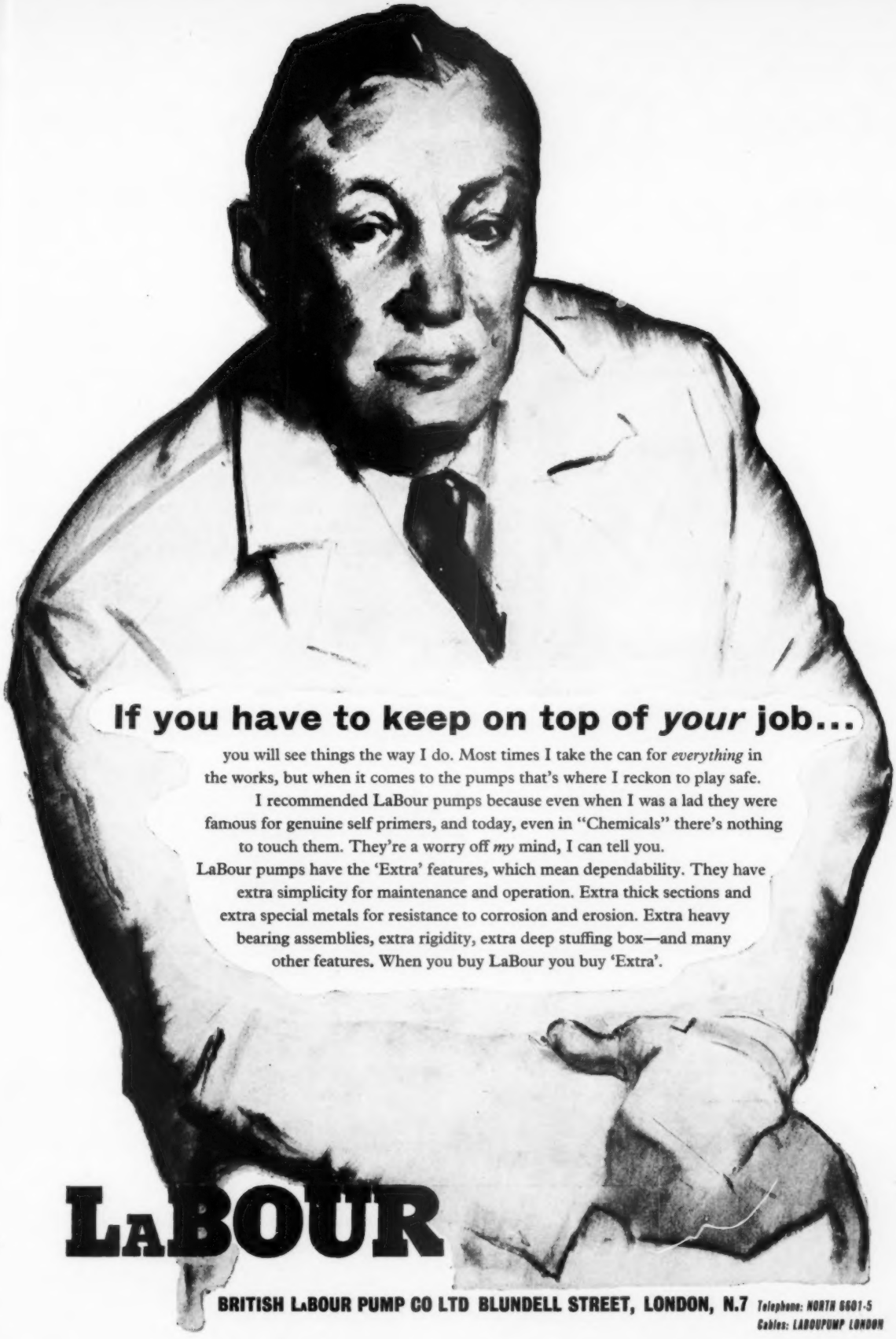

If you have to keep on top of *your* job...

you will see things the way I do. Most times I take the can for *everything* in the works, but when it comes to the pumps that's where I reckon to play safe.

I recommended LaBour pumps because even when I was a lad they were famous for genuine self primers, and today, even in "Chemicals" there's nothing to touch them. They're a worry off *my* mind, I can tell you.

LaBour pumps have the 'Extra' features, which mean dependability. They have extra simplicity for maintenance and operation. Extra thick sections and extra special metals for resistance to corrosion and erosion. Extra heavy bearing assemblies, extra rigidity, extra deep stuffing box—and many other features. When you buy LaBour you buy 'Extra'.

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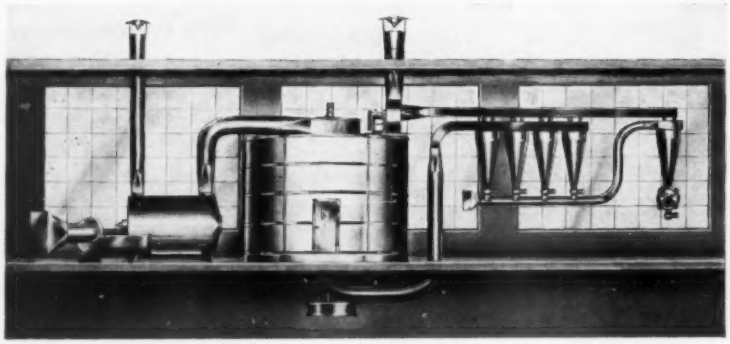
Choose the best in use

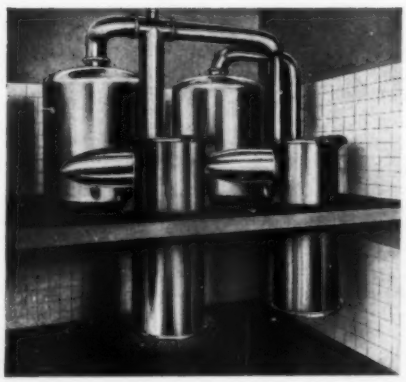
ANHYDRO

Spray Dryers *and* Evaporators



All over the world ANHYDRO is known for the highest quality and the greatest advantages. And no wonder, for ANHYDRO is far cheaper in operation and maintenance—gives the greatest reliability—improves the quality of the powder—and takes up less space.

. . . the modern system with the multiple advantages



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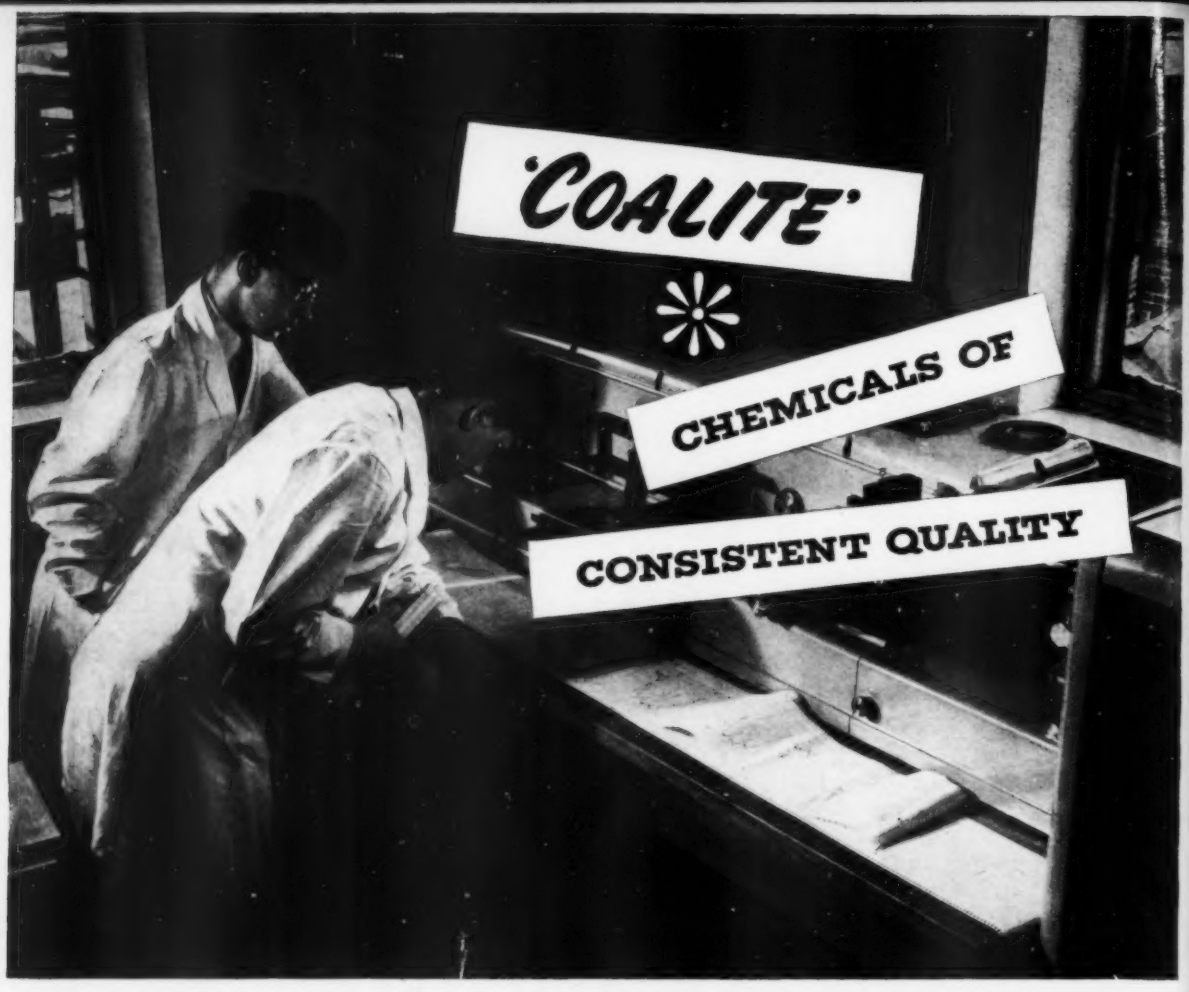

The consistent quality of "Coalite" Chemicals is ensured by the use of modern scientific aids such as the infra-red spectrograph (shown above) which carries out routine analysis on all our products.

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including white emulsion grades for use in high quality disinfectant fluids.

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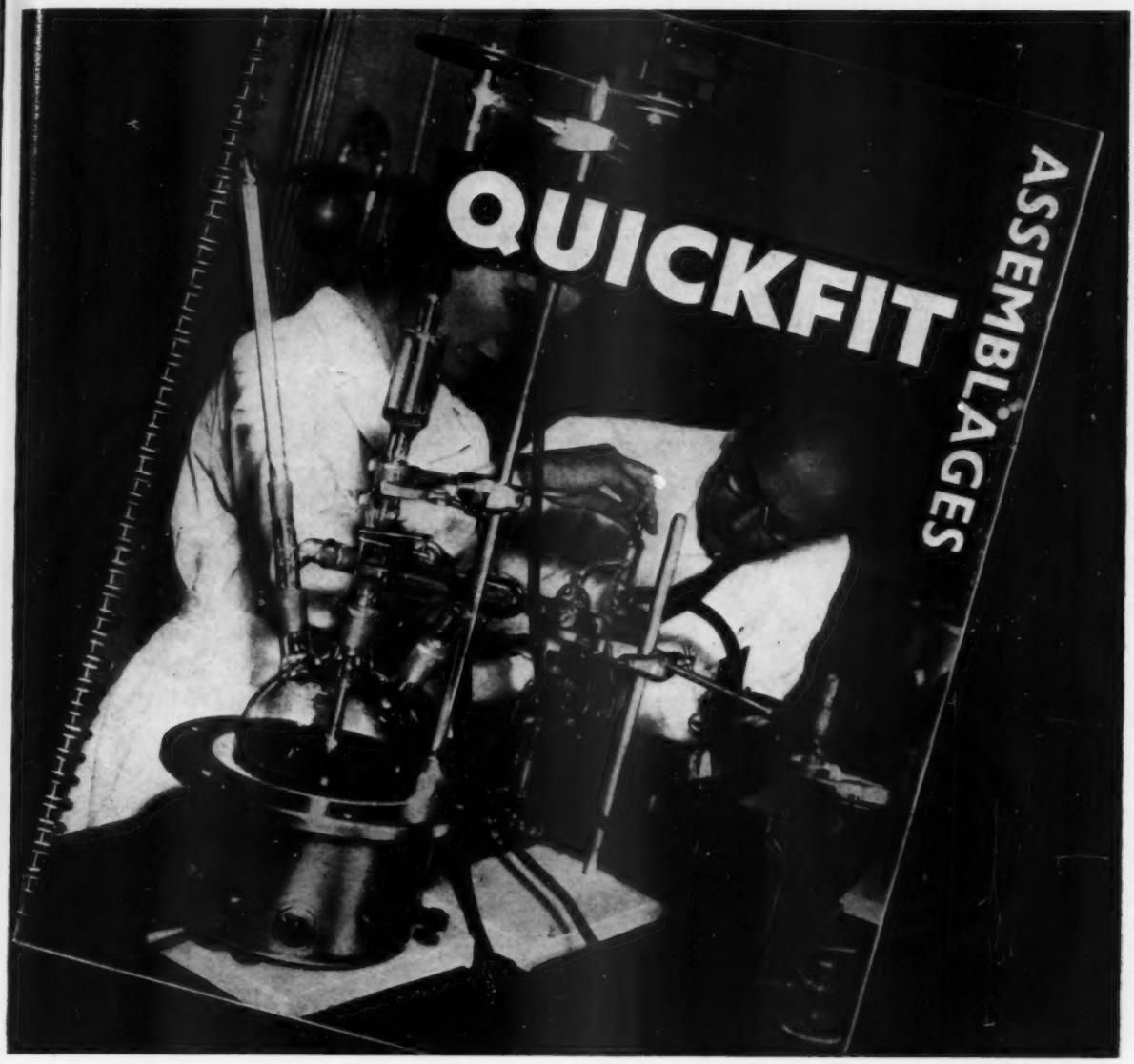
Your enquiries are welcomed and literature describing the 'Coalite' range of products is available on request.



ASSEMBLAGES

Here is a newly issued and beautifully illustrated catalogue of "Quickfit" Assemblages. Its use gives an economical and elastic method of buying laboratory glassware to meet specific needs.
A copy gladly sent at your request.

This catalogue describes three assemblages of glass apparatus all for organic chemical preparations but on different scales. Each assemblage is built up of self-contained sets of varying scope and the whole range of work is covered, from initial study in schools and universities to advanced industrial research. All components are standardised and perfectly interchangeable.

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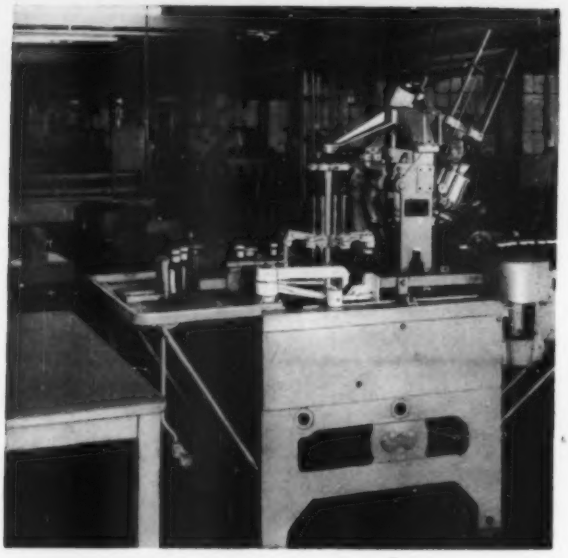
QUICKFIT & QUARTZ LTD., Dept. Y.AA, "Quickfit" Works, Heart of STONE, Staffordshire, England



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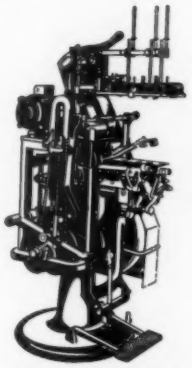
"UNIMATIC"

FULLY AUTOMATIC LABELLING MACHINES

Single or multiple labels can be applied to round, oval, flat, square, and polygonal containers, the labels being gummed all over to ensure perfect adhesion. Output depends on type of work, speeds up to 65 per minute with body labelling and up to 60 per minute with body and all-round-neck labelling.

Use PURDEX GUM in all your labelling machines.

This "UNIMATIC" at one of the Crosse & Blackwell Factories, is applying both body and neck label simultaneously, to the famous "BRANSTON SAUCE" bottle.



The "UNIVERSAL" Labelling Machine. Will apply two or three labels simultaneously such as body, shoulder and neck labels or even apply top strap labels, at the rate on simple work of up to 48 per minute.

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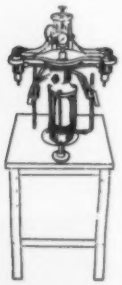
BOTTLING EQUIPMENT

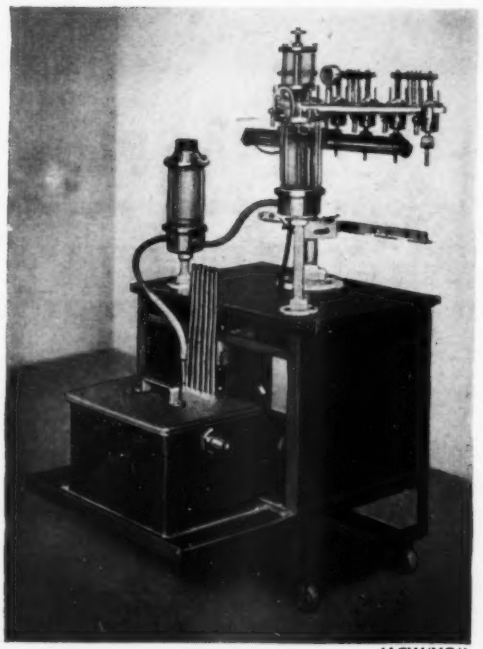


The one filling machine with four heads in pairs, worked by two operators. Gives high output in small space. Automatic overflow return.

FILLING MACHINES

Here we see a six head Filling Machine, showing automatic overflow return and float controlled feed tank. A complete portable machine used for high production of all sizes of bottles. Smaller models available from two-head up.

Sole Selling Agents for the "HORIX" semi and fully automatic gravity filling machines for liquids and semi-liquids.



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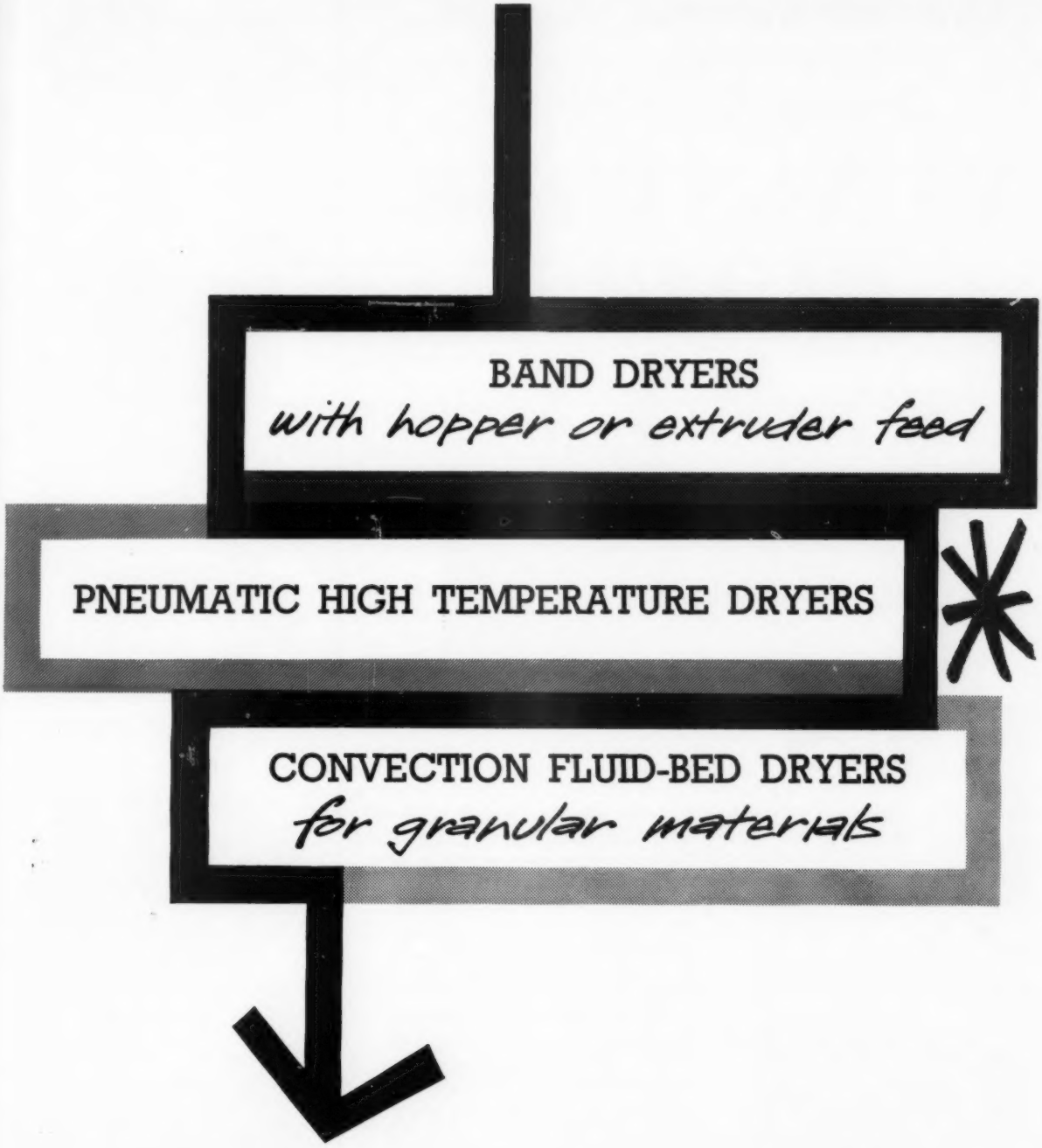


Petrie & McNaught Ltd

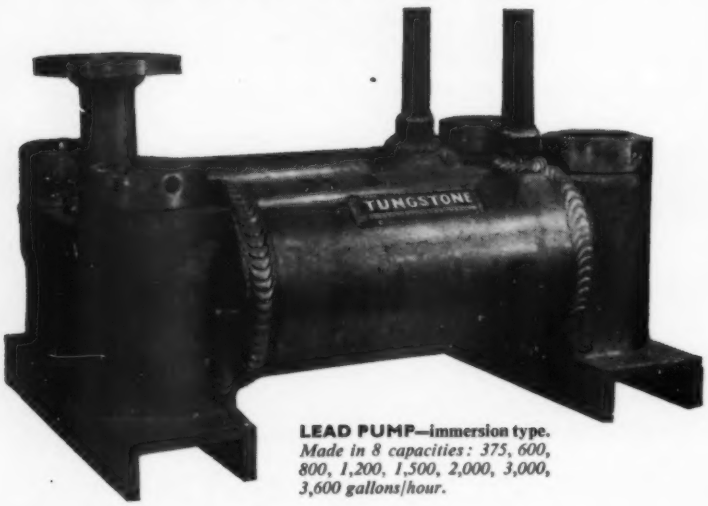
CRAWFORD STREET · ROCHDALE · LANCS

No 'awkward' liquid

(CORROSIVE, EROSIVE, STICKY OR GRITTY)

is any trouble to

TUNGSTONE PUMPS

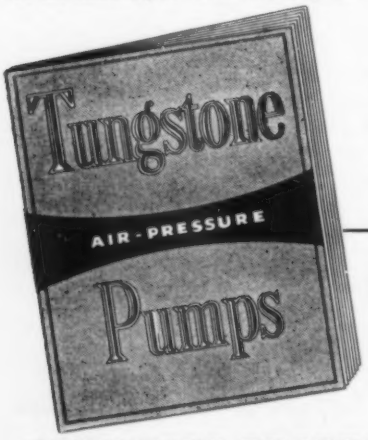


LEAD PUMP—immersion type. *Made in 8 capacities: 375, 600, 800, 1,200, 1,500, 2,000, 3,000, 3,600 gallons/hour.*

Which particular liquid in your business presents its pumping problem? Is it an acid, a slurry, a sludge . . . gritty, greasy, corrosive, erosive, sticky? A TUNGSTONE Pump will quickly take care of that—as many industries have proved.

These fine pumps specially evolved for the handling of 'awkward' liquids have two valuable features: (a) the unit can be supplied in a range of materials which resist corrosion by any particular liquid, (b) there are no packings or glands within the unit and there is nothing to clog or choke—air is used as a piston, although it never mixes with the liquid: maintenance costs are negligible.

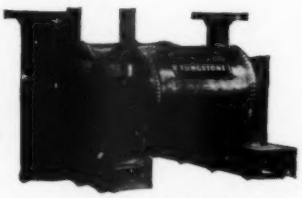
For any given pumping pressure the volume of air going to the pump can be controlled so that the pump's output can be varied from zero to maximum. The pump and whole length of delivery pipe containing valuable liquid can be emptied after each operation at the end of a shift.



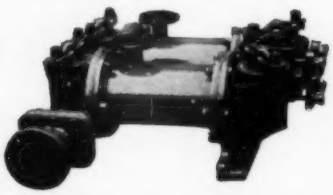
FREE

A fully explanatory, illustrated brochure describing TUNGSTONE Air Pressure Pumps, sent on request.

EBONITE PUMP, non-immersion type. Made in 3 sizes: 200, 375, 600 gallons/hour.



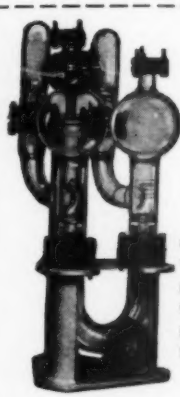
non-immersion LEAD PUMP. Made in 8 capacities: 375, 600, 800, 1,200, 1,500, 2,000, 3,000, 3,600 gallons/hour.



NICKEL/CAST IRON—10 sizes: 375, 600, 800, 1,200, 2,000, 3,000, 3,600, 5.000, 7,500 and 9,000 gallons/hour.

RUBBER LINED NICKEL/CAST IRON—8 sizes, 800 to 9,000 gallons/hour.

EBONITE PUMP, immersion type. Made in 3 sizes: 200, 375, 600 gallons/hour.



GLASS PUMP— "Pyrex" brand Borosilicate Glass. Made in two capacities: 300 gallons/hour and 800 gallons/hour.

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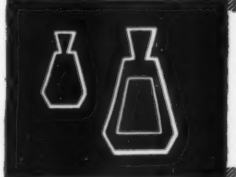
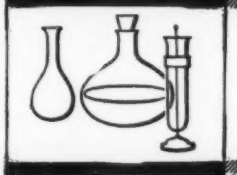
TEXTILE APPLICATIONS

OXITOL, DIOXITOL, Methyl OXITOL and Butyl OXITOL—used as solvents in textile dyeing and printing, giving improved fastness and brightness.



PHARMACEUTICALS AND COSMETICS

OXITOL and Methyl OXITOL — used as extractants and recrystallisation solvents in the manufacture of antibiotics. Methyl OXITOL — solvent for odourless nail varnishes.



CHEMICAL MANUFACTURE

Butyl OXITOL—used for esterification of 2,4-D to give a non-volatile weed killer.

Methyl OXITOL, Butyl OXITOL and OXITOL—esterified to give phthalate plasticisers.

INSECTICIDES

Butyl OXITOL — used in the preparation of piperonyl butoxide, a synergist for pyrethrum sprays.

Methyl OXITOL	=	Ethylene glycol monomethyl ether	OXITOL Acetate	=	Ethylene glycol monoethyl ether acetate
OXITOL	=	Ethylene glycol monoethyl ether	Methyl DIOXITOL	=	Diethylene glycol monomethyl ether
Isopropyl OXITOL	=	Ethylene glycol monoisopropyl ether	DIOXITOL	=	Diethylene glycol monoethyl ether
Butyl OXITOL	=	Ethylene glycol monobutyl ether	Butyl DIOXITOL	=	Diethylene glycol monobutyl ether

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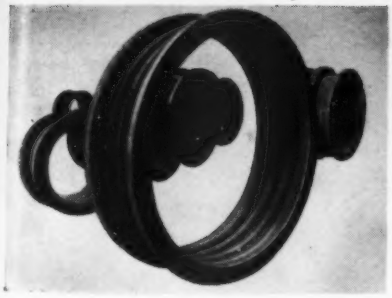

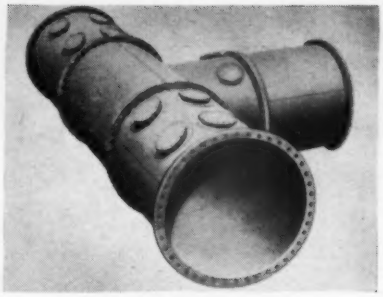

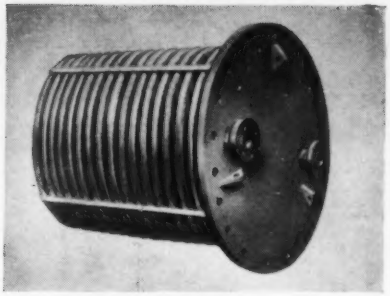

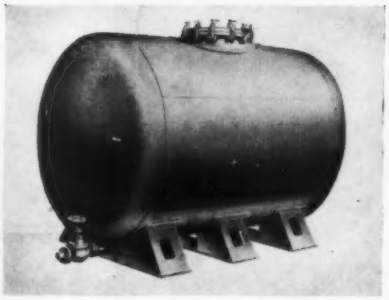

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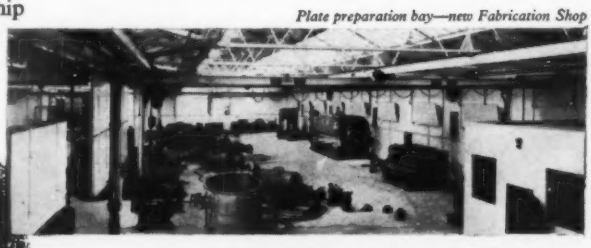

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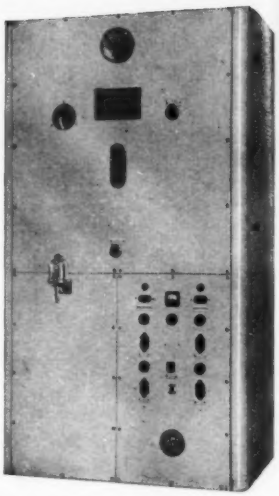

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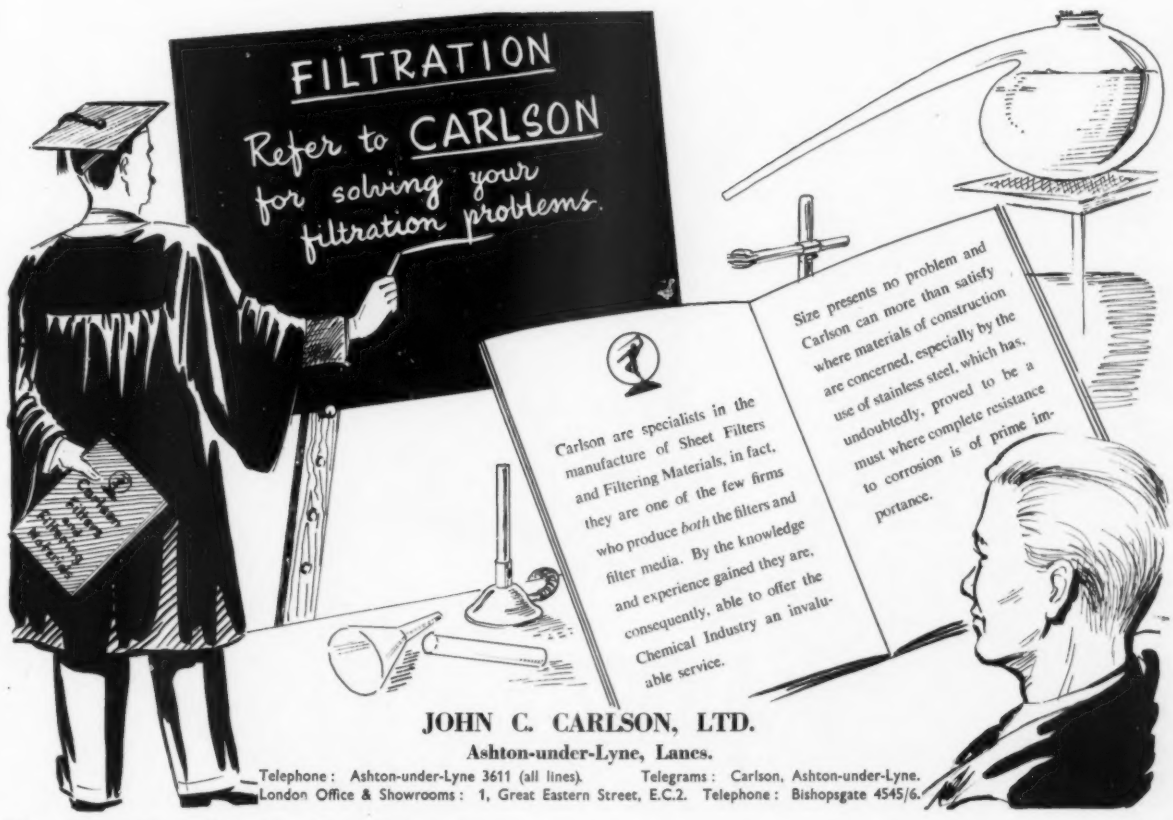
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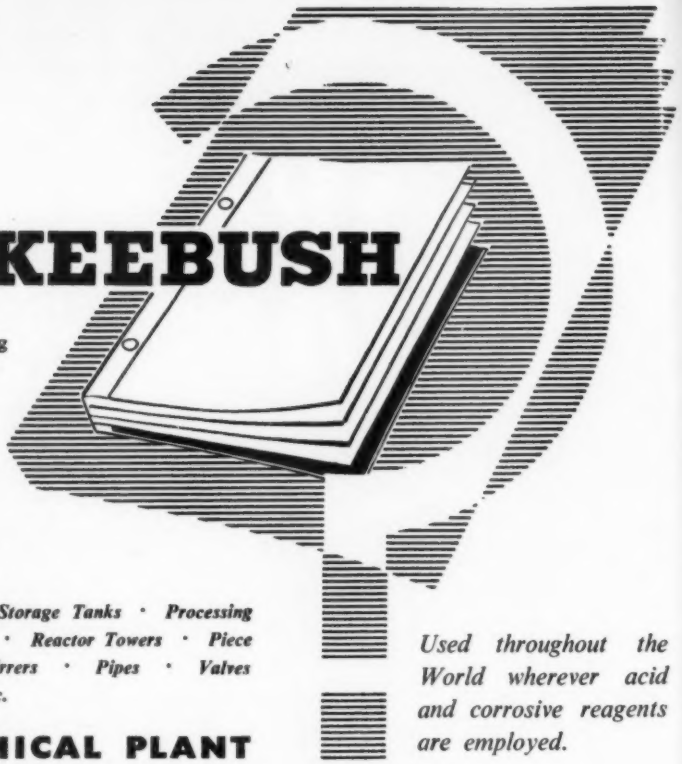

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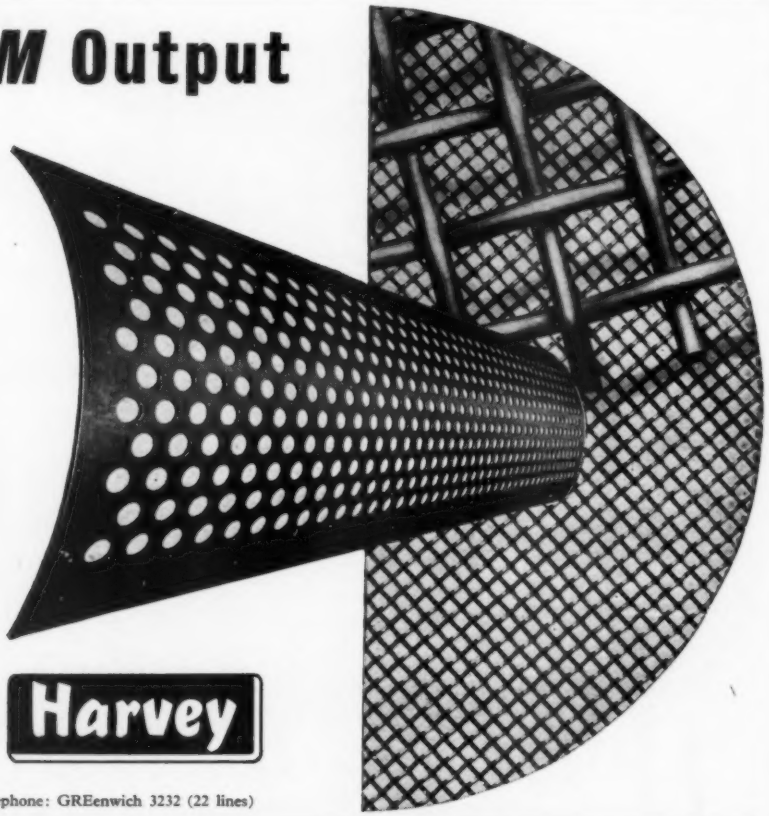

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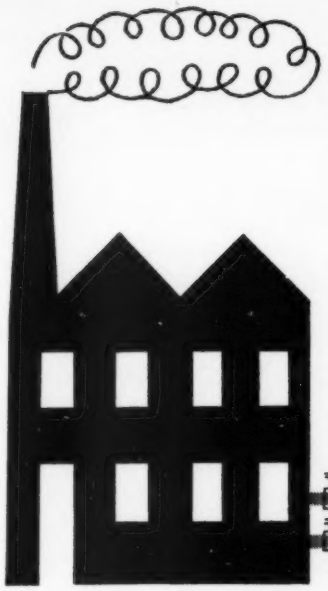

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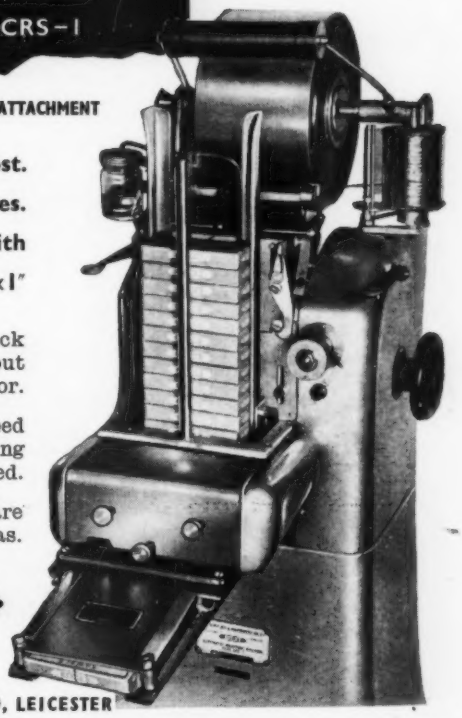

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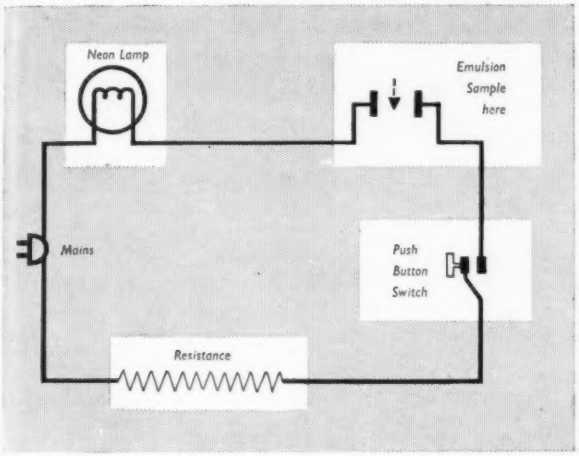
4 determining emulsion type



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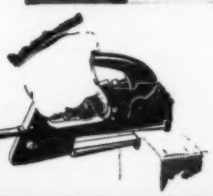

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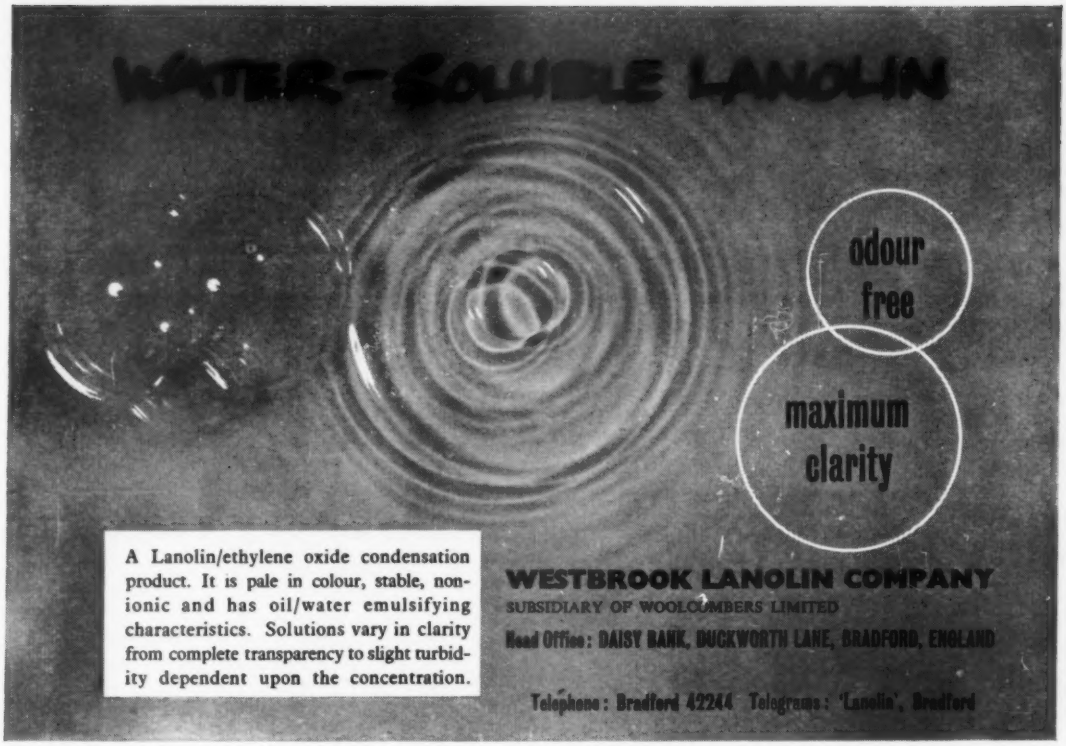
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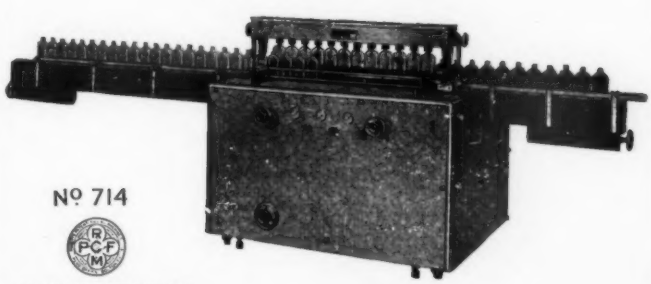

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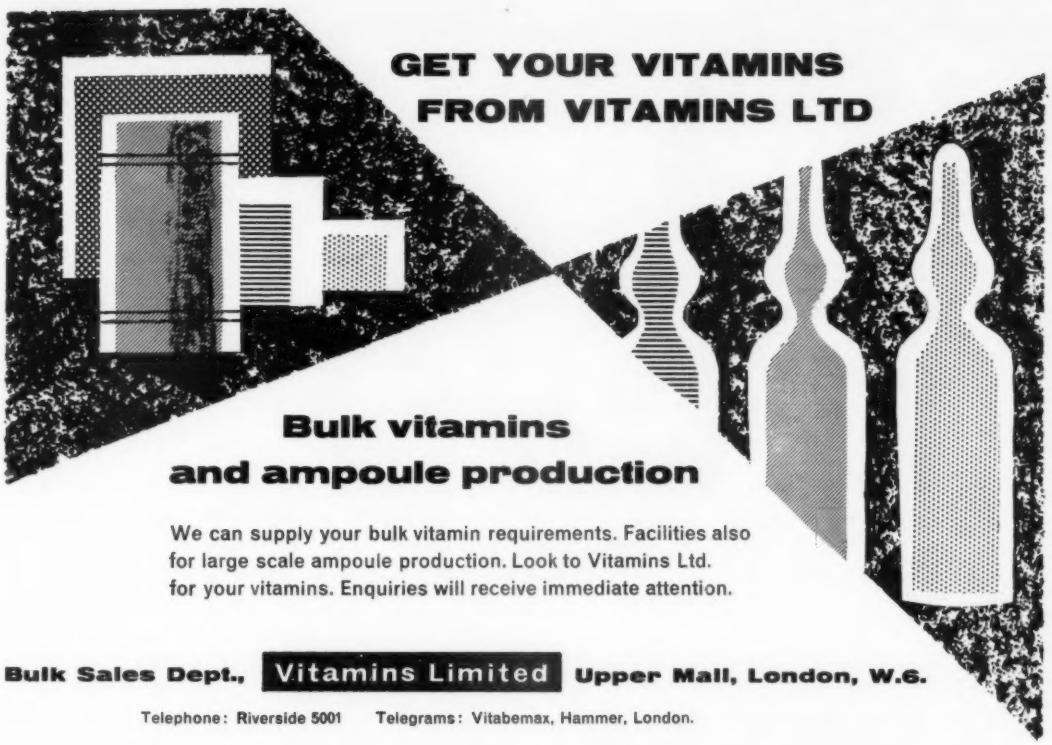

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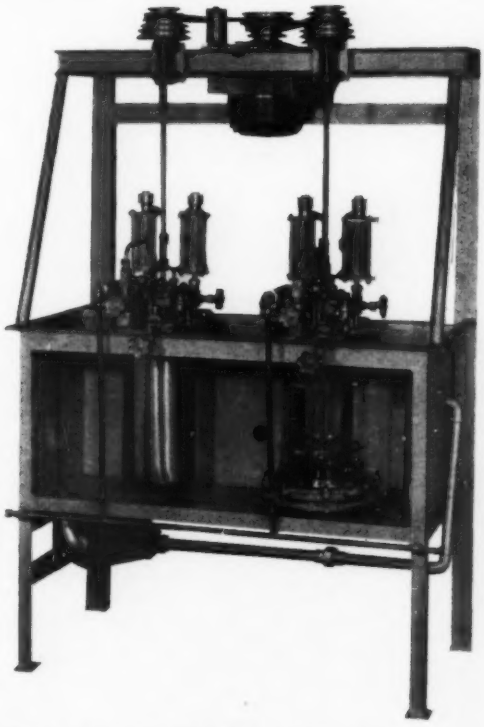

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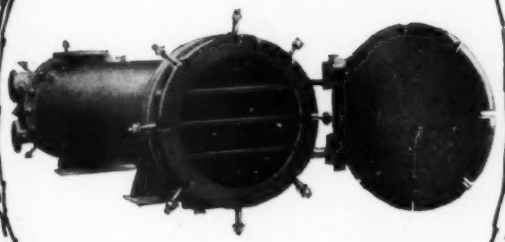

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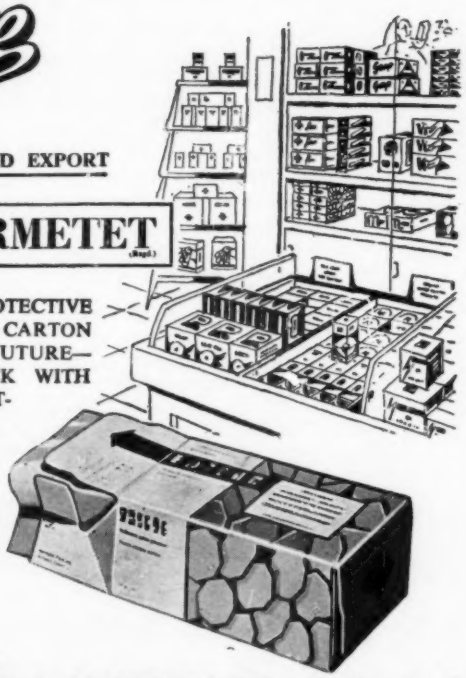

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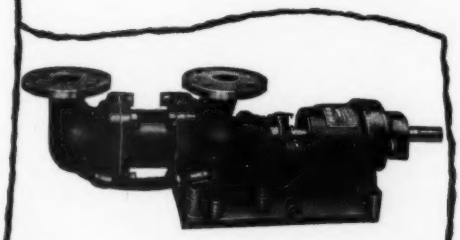

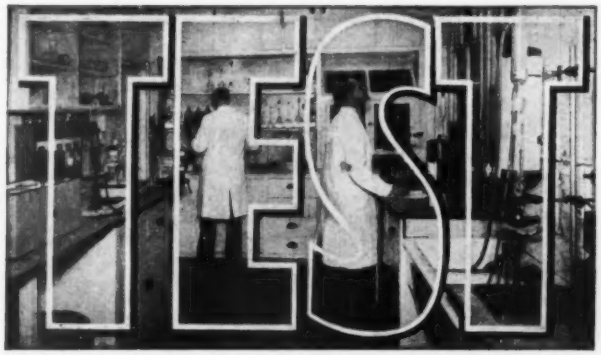

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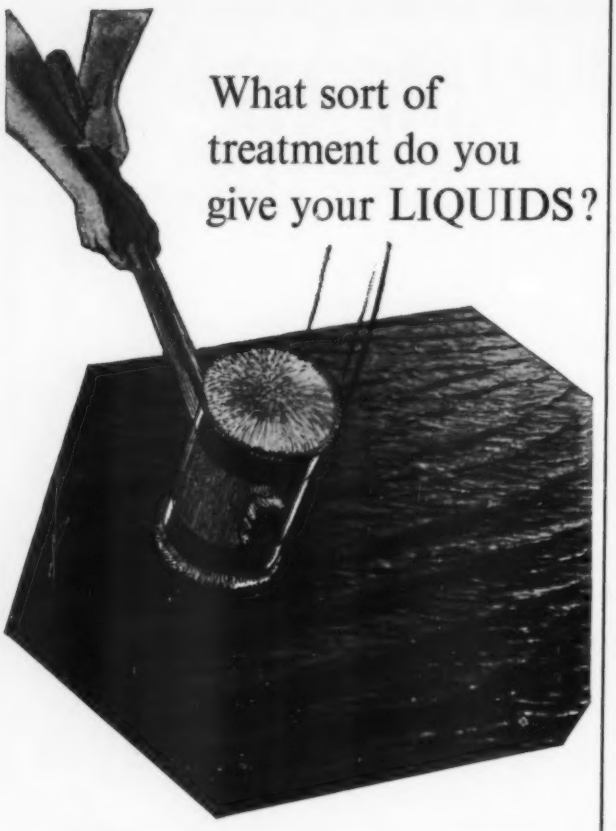

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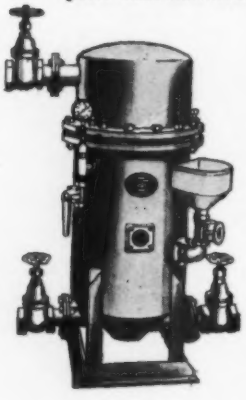

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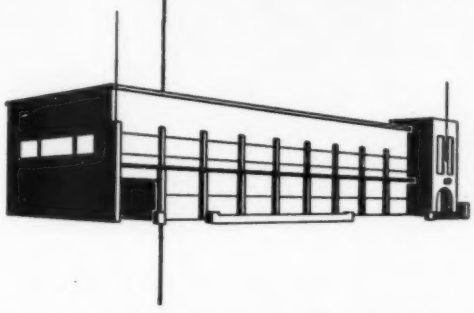

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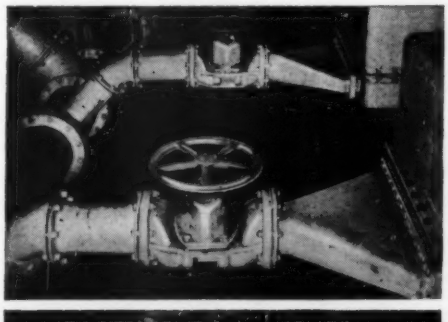

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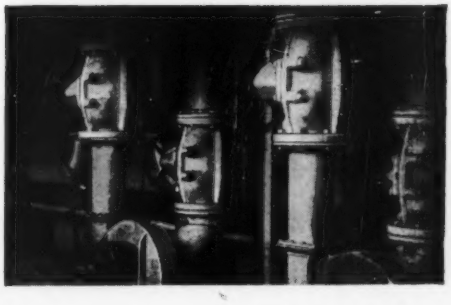

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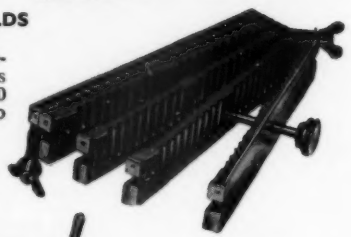

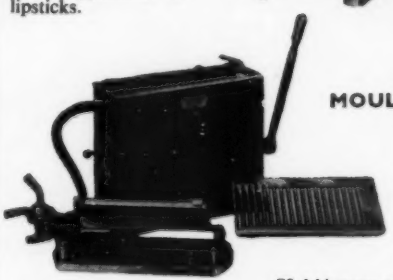

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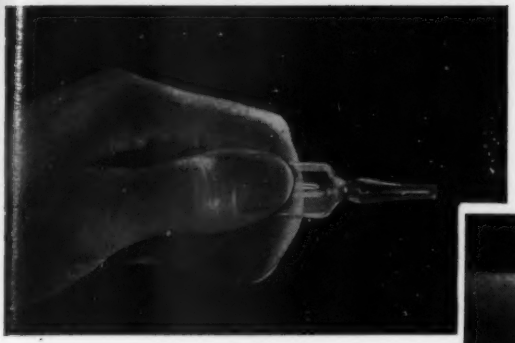

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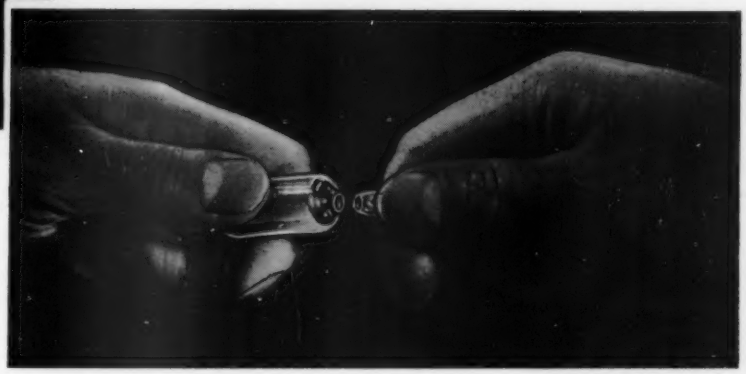

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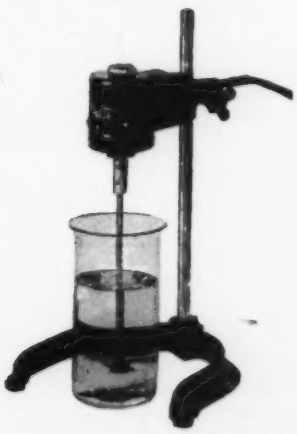

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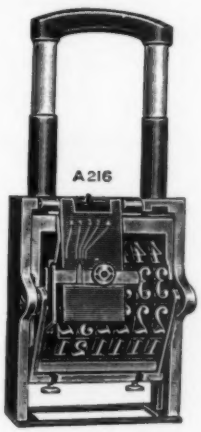

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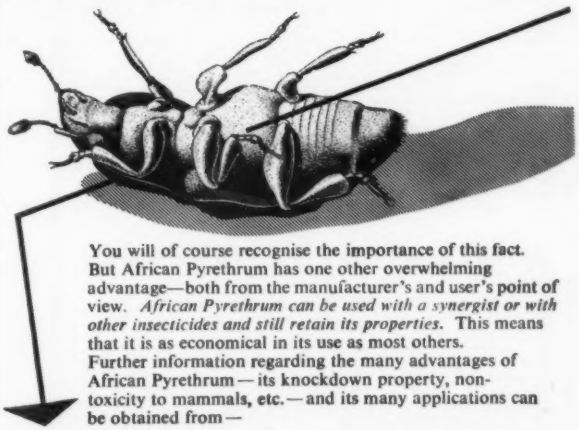

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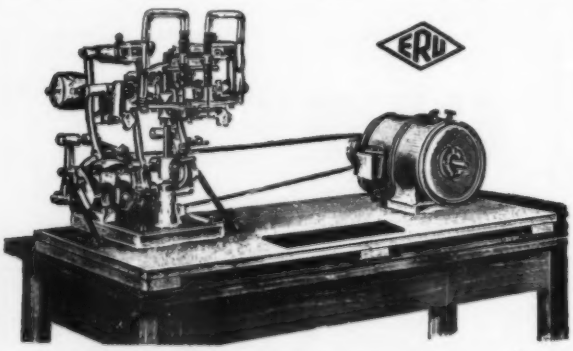

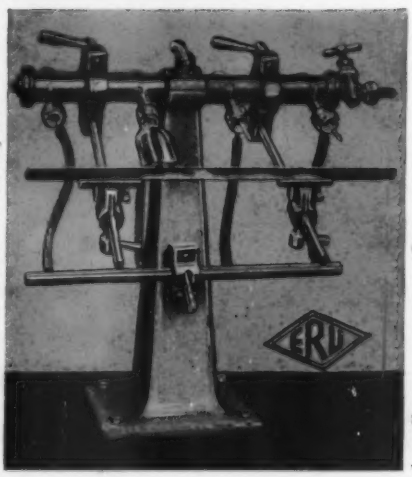

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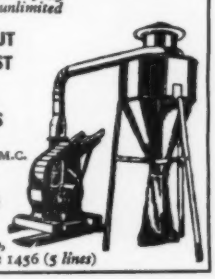

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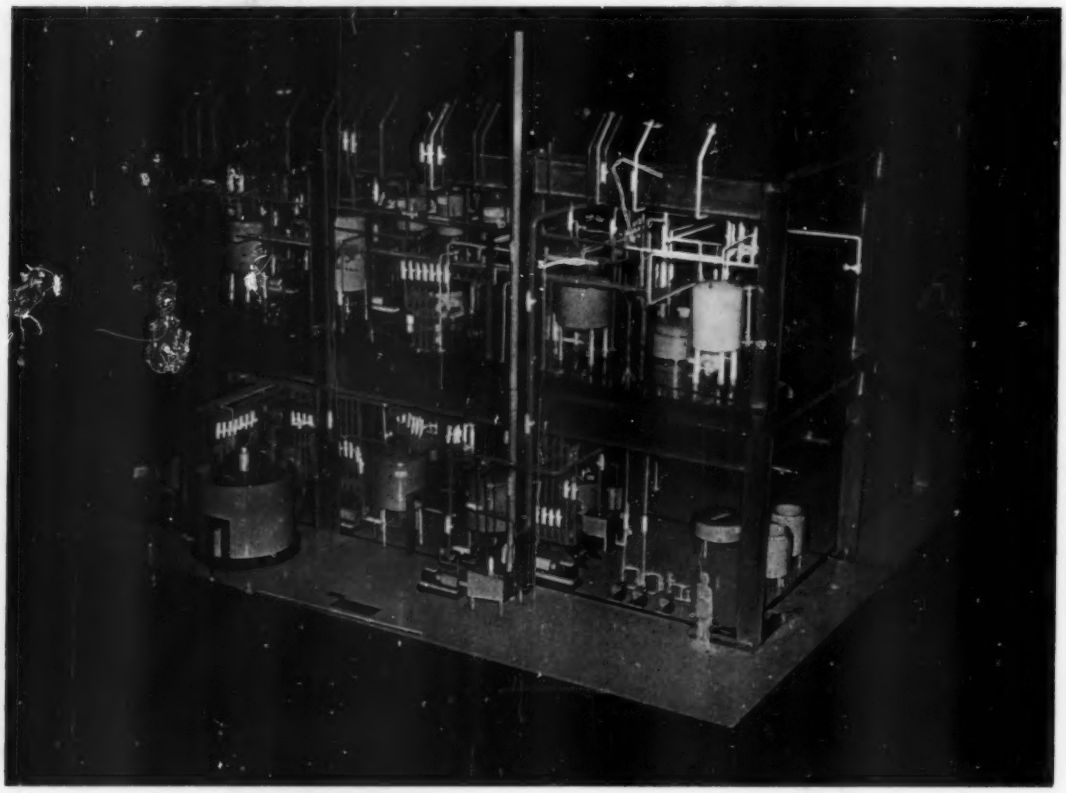

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